Light and Lighting

Vol. XLVIII.—No. 6

June, 1955

Published by The Illuminating Engineering Publishing Co., Ltd., on the 1st of each month, at 32, Victoria Street, London, S.W.1. ABBey 7553. Subscription rate 25s. per annum.

CONTENTS

Colour and the Lighting Engineer

OPINIONS differ as to the role of the lighting engineer. It has been said that all he has to do is to produce arrangements of brightness, and it has also been said that if he is to produce satisfying arrangements of brightness, and to produce them economically, he must have some say in the matter of interior decoration. In fact, however, he has not only to produce acceptable arrangements of brightness but to do so without producing unacceptable arrangements of colour, and so there is a double reason why he should concern himself about decorations. The modern lighting engineer works with a range of light sources which, for all their nominal "whiteness," vary in colour-rendering properties. The source he uses in any particular installation needs to be chosen with reference to the colours of room decorations (and other things), or these colours need to be specified with reference to the proposed light source. Moreover, a wall colour that will be acceptable with a given illuminant and a given level of illumination may not be equally acceptable with the same illuminant at a lower illumination, although it may be pleasing if the lower illumination is obtained with a different illuminant.

Notes and News

Fluorescent Lighting in Schools

The French Ministry of Education has just issued a new code on lighting in schools. The code includes some recommended levels of illumination; though these are rather on the low side they at least show that the officials concerned are beginning to take a rather more intelligent interest in lighting.

The most important feature of the code, however, is that the ban on fluorescent lighting in French schools has now been lifted. This is a matter of considerable importance. The ill-conceived ban imposed some years ago did much damage and provided very welcome ammunition for those who for reasons best known to themselves wish to arrest the development of fluorescent lighting. Let's hope that in time they will follow the example of the French Government and admit their error. It is suggested in the document that fluorescent lighting should be used only where the hours of use justify it, a recommendation with which there can be no quarrel.

The code also refers to maintenance and recommends that luminaires be chosen and installed so that they can easily be serviced and cleaned. This matter of maintenance, not only in schools, is an important one and we are glad to see signs that more attention is being given to it in the design and planning stages.

No Politics

As we write the battle of the parties seems hardly to have begun; by the time you read it we will all have forgotten the battle and will have resigned ourselves to whatever form of government we have democratically inflicted on ourselves for the next few years. One party which many of us will not forget in a hurry was the I.E.S. dinner and dance which took place towards the end of April. We wouldn't say it was a riot, we didn't eat off gold plate and if wine flowed like water we didn't notice it; nevertheless, it was one of the happiest parties we had been to for a long time. There is something indefinable about I.E.S. members and their social functions; however much they may try to do one another in the eye in their business capacities as manufacturers, sellers or installers, once they get together they cast away the cares of the day and all become jolly good fellows. And this is true of all I.E.S. social functions wherever they may be held about the country. The view of the secretariat we understand is that they have only to get sufficient people together for a party to be a success; they may be nearly right but we can't help thinking that there is a little something which they themselves add and which has some effect on the final result.

Speeches can, of course, make or mar a dinner. The I.E.S. always tries to keep them short but once a determined speaker gets on his feet there is nothing anyone, other than the speaker himself, can do to speed the programme. At the Cafe Royal, in April, all the speeches were brief and to the point, four of them being delivered within 25 minutes. That isn't bad going; the record was at Harrogate in 1948 when the time for the same number of speeches was 19 minutes, though this was nearly challenged at Southport last year when the first three runners came home in less than 15 minutes. Anyway, full marks to Messrs. Lennox, Eccles, Harper and Creer for their efforts on April 20.

Design on Show

The Council of Industrial Design, set up some 10 years ago to improve the design of goods made in this country, has suffered from the absence of a permanent place at which well-designed consumer goods can be displayed. This is to be put right next year when the C.O.I.D. will move to new premises in Haymarket at which there will be ample ground floor accommodation for a permanent and constantly changing display of the best designs from British industry.

In its short existence the C.O.I.D. has made great progress. It started on a very sticky wicket but has stood up to and learned by the criticism levelled at it and its usefulness and influence is now beyond doubt. During its 10 years the Council has been responsible for selecting exhibits for some 150 exhibitions at home and overseas which have been seen by more than 18 million people. Firms in the lighting industry will no doubt see that the best examples of their art get frequent showing in the new national showroom.

Light and the Designer

That the interior decorator and also the designer of such essentials as textiles, carpets, furniture and pottery, should have a vital concern about colour is obvious. It has not always been appreciated, however, that this has meant in turn that these people should also be concerned about light and lighting.

It is satisfactory to note, therefore, that the British Colour Council in organising their Designers Conference in London in the first week of May included not only a visit to some lighting showrooms but also a paper dealing with the interaction between light and colour. The lecturer was Mr. H. Hewitt, who dealt with the role of lighting in providing acceptable colour rendering and the way in which light and lighting fittings can contribute to decorative colour schemes.

We thought the occasion might reveal whether the designer feels that he receives real assistance from the lighting engineer or whether he feels that his handiwork is sometimes ruined by the misuse of the numerous light sources now available. True enough during the early part of the conference the usual critical remarks about lighting engineers and their light sources and other hardware were made; but in the lengthy discussion on Mr. Hewitt's paper not a murmur of criticism was heard. Perhaps Mr. Hewitt covered the ground too thoroughly; or maybe in the presence of an expert (we use the term deliberately) the critics are not very brave.

New Lighting Code

As announced by our colleague " Lumeritas " last month a new edition of the I.E.S. Code for Lighting in Buildings is about to make its appearance; we hope that by the time these words are read the new Code will be available. We have been privileged to see an advance copy and can say that the new version is far superior in both content and presentation to any of its predecessors.

The status of the Code has steadily increased ever since it was first published in 1936 when it was merely a schedule of recommended values of illumination. This schedule, having been extended and brought up to date from time to time in the light of further research and experience, is now an appendix to the Code the main text of which deals with the principles of good lighting and sets out rules and recommendations for the guidance of engineers, architects and users.

In case there should be any misguided people who imagine that a Code such as this is compiled on a hit or miss basis it is pointed out that the statements and recommendations are founded upon scientific facts and an impressive list of references is given.

Copies of the Code (price 5s.) may be obtained from the I.E.S., 32, Victoria Street, London, S.W.1.

Lighting and the Architect

The recently opened exhibition with the above title (Crown House, Aldwych) has been arranged by the British Thomson-Houston Company to demonstrate to architects (and others) that the lighting of modern buildings is not simply a question of choosing appropriate lighting fittings. Nor, for that matter, is the problem one that can be solved by passing over to a lighting engineer a set of one-eighth scale drawings and asking him to " design a scheme." At that stage it may be too late !

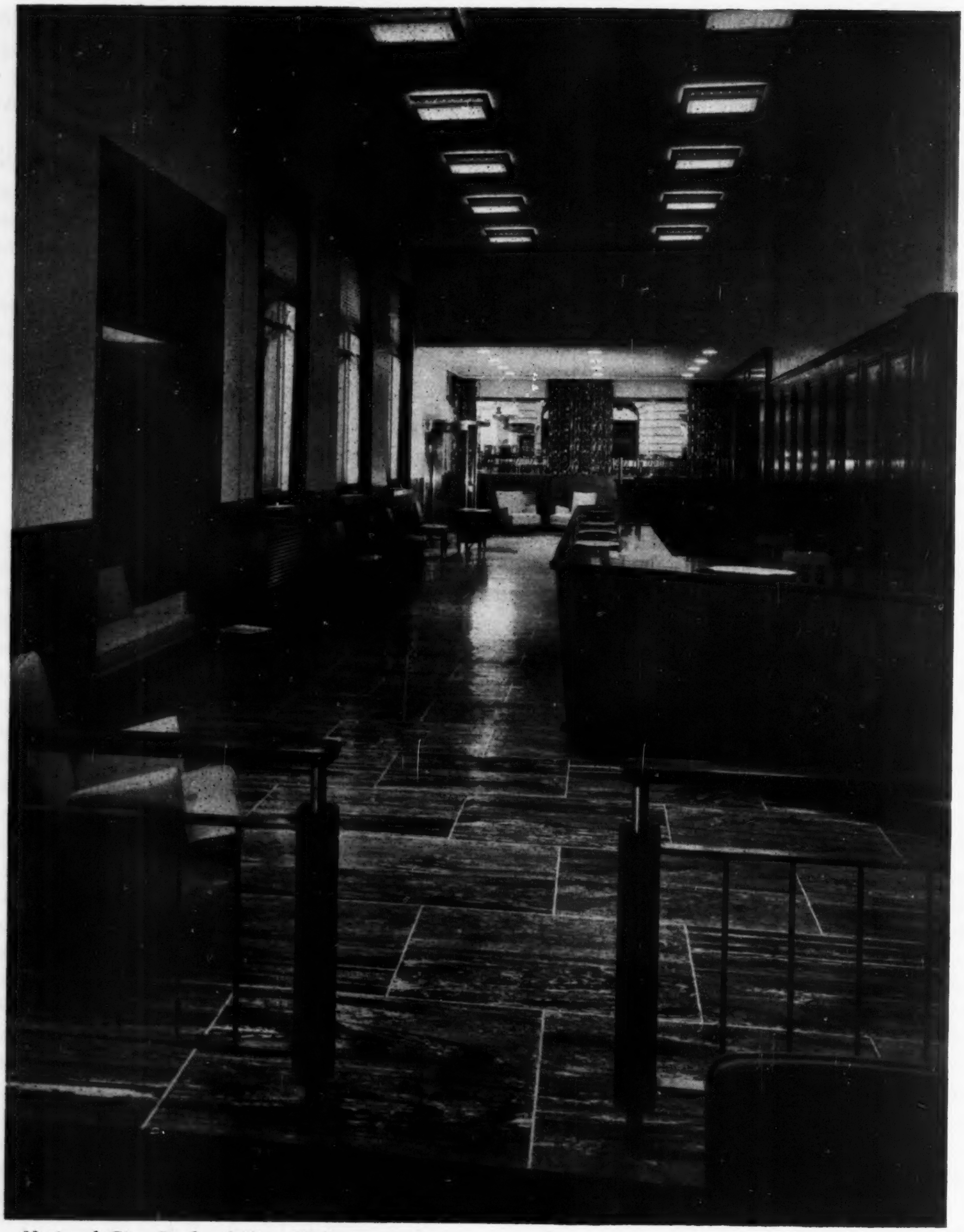
The point the organisers of the exhibition are trying to put over is that, at the design stage, the appropriate *system* of lighting should be chosen, so that, at each later stage, lighting requirements can be properly taken into account.

On show at the exhibition are various fittings and items of equipment designed for use in conjunction with suspended ceilings. These include recessed fluorescent fittings in dimensions chosen so that, when used with ceiling systems designed on a 2-ft. grid, no cutting of ceiling panels is required. (Similar fittings for use in buildings designed on the 40-in. module are also available.)

Incidentally, the current vogue for suspended ceilings makes us wonder whether there is not, sometimes, a tendency to use them indiscriminately, in order, perhaps, to provide space for services which could have been housed elsewhere if someone had remembered in time ! Of course, when the nature of the floor construction makes it undesirable that it should be revealed, or when there is an unusual multiplicity of services, the suspended ceiling is the ideal solution, but, at other times, it may be a means of avoiding a problem rather than a means of solving it.

A form of construction that presents a very special lighting problem is the shell roof, the beauty of which is completely destroyed if a confusion of lighting fittings and conduit is attached to or suspended from the underside. At their exhibition, B.T.H. demonstrate one of the neatest solutions to the problem : the roof is pierced by rectangular openings at regular intervals, of suitable dimensions to house specially designed fluorescent fittings. (Piercing the concrete presents no structural problems, provided the engineer is brought into the picture at an early stage.) The fittings project above the roof, where they are enclosed by a concrete " box," with a hinged lid for access, and wiring (in plastic conduit) is either in the concrete or on its external surface. In spite of the inconvenience of clambering on the roof in the rain to replace fluorescent lamps, access from above has the important advantage that there is no interruption of factory production.

Several other approaches to the solution of lighting problems are demonstrated at this well-presented exhibition and we can recommend a visit—to lighting engineers, as well as architects.



National City Bank of New York,
London, S.W.1.

The Lighting of Offices

A review of the problems of artificial lighting in offices and recommendations on how they might be overcome.

By D. J. REED*

A perusal of technical publications dealing with lighting issued during the last five or six years has yielded no reference to office lighting. The only published data during that period is to be found in "The Lighting of Office Buildings," Post War Building Studies No. 30, published in 1952 by H.M.S.O., from which material for this article has been freely taken.

A survey amongst office workers carried out by Grey and Corlett(1) in 1952, in which 1,408 interviews took place, showed the following interesting results:—

Types of light source:	
Tungsten	76 per cent.
Fluorescent	19 „ „
Both	5 „ „
Types of lighting fitting:	
Direct	68 per cent.
General	28 „ „
Indirect	4 „ „
Average service illumination:	
Below 10 lm/ft^2	37 per cent.
10—20 lm/ft^2	37 „ „
Above 20 lm/ft^2	26 „ „

The proportion of workers in different types of office occupation working under less than 10 lm/ft^2 were as follows:—

Draughtsmen	3 per cent.
Typists	29 „ „
Machine operators	31 „ „
Ledger clerks	36 „ „
General clerks	47 „ „

These figures alone show that there is still a lot to do to improve lighting conditions for office workers.

An analysis of the visual tasks and lighting problems together with illumination recommendations are given below for private, typing, general clerical, accounting, filing and drawing offices.

Problems

It is well established that the quantity of light required for any task is dependent primarily upon the size of detail involved, its definition, the contrast between the main object of regard and its immediate background and the duration of the operation. Secondary considerations are the age and environmental conditions of the person performing the tasks.

Most of the tasks carried out in offices include a large amount of visual application similar to reading, although in a few cases the question of manual dexterity must be taken into account. The problem is to determine an adequate and suitable illumination level based on the following data.

The main objects of regard are typewritten or handwritten words and figures and the lines on drawings, and, so far as the size of detail is concerned, it may be taken that the classification would be in the "small" or "very small" groups of the I.E.S. Illumination Chart(2). While it may be argued that handwriting is in some cases larger than typewritten material and should therefore be classed larger than "small," having regard to the degrees of legibility, the ranges of size and style and the extent of the reader's familiarity with the script, there is some justification for keeping within the "small" classification.

A considerable range of contrasts is to be found among the visual tasks performed in offices. Top copies of typewritten documents have a good contrast, but the contrast on carbon copies gets progressively poorer due to the reduction in definition and impression resulting from the "deadening" effect of successive layers of paper. Carbon copies are often taken on coloured paper; if the colours are ill chosen the contrast can be further reduced.

Shorthand notes are often inscribed with pencil, and because a sharper point can thus be kept for a longer time hard pencils are frequently used, although a soft lead would give a better contrast.

With pencilled notes, whether in longhand or shorthand, the best contrast between writing and paper is obtained by working with a soft lead pencil on a good white paper, whilst poor contrast will result from using a hard pencil and a tinted paper. Shorthand notes should be written in ink; professional shorthand writers always write in ink, and shorthand writing schools recommend the use of pen rather than pencil.

Tables of figures generally present a good contrast, but the individual numbers are sometimes smaller than letters and spaced more closely, calling for a reasonable level of illumination.

Typing involves long periods of reading from shorthand or from copy. Shorthand notes, as mentioned above, may, if inscribed with a hard pencil, have a poor contrast and require a high illumination to be read with ease. Copy typing is often from unfamiliar handwriting which may be small and illegible, and which may include spelling errors that have to be corrected and abbreviations which have to be typed in full. It may be from carbon copies of original documents which, it has been noted, may be of poor quality and need a high illumination to be read easily. Also the eyes of the typist have to adjust themselves to the different contrast each time

* The General Electric Co., Ltd.

she alters her gaze from her own work to the notes or copy and back again.

In large general offices there is very often a lack of symmetry in the arrangement of desks, and so the lighting installation must be capable of providing general illumination from all directions. There is often a considerable amount of noise which distracts attention, and a reasonably high level of illumination must be provided to permit of the required degree of concentration. This distracting noise differs from that which occurs in typing pools in that it is intermittent and irregular. In a typing pool the noise is consistent and in a very short time becomes so familiar as to be ignored.

Due to the arrangement of desks, and to the type of work involved, clerical workers must be able to look in any direction in the office without receiving glare from lighting fittings. Much of their work entails handwriting and reference to documents having a wide range of contrasts. Usually the work is horizontal.

The visual task in a mechanical accounting office is essentially different from ordinary office work and involves visual tasks of greater severity. For instance, the punching of the keyboard is less automatic than the operation of a typewriter, and over a period of time imposes a strain in locating the correct keys in the correct columns, checking the numbers and reading the answers. All these processes are in addition to the initial reading of the informative data. A similar kind of strain is experienced if large tables of figures are being set up in which it is difficult to locate the individual numbers.

In both these kinds of work the need for adequate lighting is clearly important because it affects the speed with which the details can be identified and located.

Without doubt, the visual tasks in drawing and tracing offices are the most severe of those covered in this article. Firstly, much of the work consists of fine lines drawn with a hard pencil, and these are often difficult to see due to their faintness. Secondly, considerable care is required for the accurate location of lines and centre points for geometrical instruments, and this involves a high visual acuity and concentration of gaze upon small fields of view at close range for relatively long periods. Thirdly, it is frequently necessary to adjust drawing instruments accurately to finely divided scales. Lastly, the task of making tracings from faint drawings is made more difficult by the tracing paper or linen, and constant close inspection is needed to detect the details and ensure that the trace is accurate.

From the above it will be agreed that a high level of illumination is required so that fine details having a poor contrast may be seen easily without bringing the eyes so near to the work that eye-strain results from excessive focusing and convergence of the eyes.

Illumination Levels

Taking into account the points mentioned above, and considering them in relation to the investigations carried out by Taylor and Weston([3]), the following recommendations for the lighting of different types of offices are made :—

(1) Enquiry offices, reception and waiting rooms, and entrance halls	6 lm/ft^2 (at floor level)
(2) Private offices, where the occupant devotes most of his time to interviews rather than close work of a sustained nature	15 lm/ft^2 (at desk level)
(3) Private offices, where the occupant spends most of his time performing visual tasks of an exacting nature	20 lm/ft^2 (at desk level)
(4) Book-keeping, typing, computing machines, filing, cashiers' counters and other general offices	20 lm/ft^2 (at desk level)
(5) Drawing offices and tracing offices :	
Ordinary work	30 lm/ft^2 (on boards)
Fine work	50 lm/ft^2 (on boards)

The above values, while not necessarily permitting of maximum visual efficiency, will ensure a reasonably high standard of performance.

It is realised that in some large general offices there may be sections which are used intermittently, and in these areas a somewhat lower level of illumination can be tolerated provided the overall average for the room is not less than 80 per cent. of the recommended value; this should not, however, be taken as a mandate to design installations giving a lower level of illumination than those recommended above.

On the other hand, it is an advantage, if economic considerations permit, to provide levels of illumination higher than those recommended. This would apply especially where workers of over 40 years of age are employed when illumination levels require to be increased to compensate for the loss of accommodation by the eye as people get older.

Brightness

The provision of an adequate illumination is not of itself sufficient to ensure optimum visual efficiency but must be considered in relation to the entire field of view of the worker. Care must be taken to ensure that the worker is free from the discomfort of disability glare; the best conditions are achieved where the immediate surround has a general brightness slightly less than that of the work. Thus, for maximum comfort, desk tops should be light in colour and should not be capable of causing bright irritating reflections of light sources towards the eyes of the worker. The lower parts of walls should not be materially darker in colour than the rest of the room because, with the desk or table top, this area forms a large part of the worker's immediate field of view. It should not be assumed that a uniform appearance should be given to a room; the monotony of such an arrangement would mitigate against the efficiency of the worker.

Violent changes from one colour or brightness to another are equally to be deprecated because these can result in discomfort and may even distract attention from the work. Gradual changes, providing variety in the general field of view, should be aimed at. Uncovered windows at night-time present large dark areas which are unpleasant in a bright interior. Light-coloured blinds should be used as much as possible to maintain an acceptable brightness ratio throughout the room.

The excessive brightness of light sources in the field

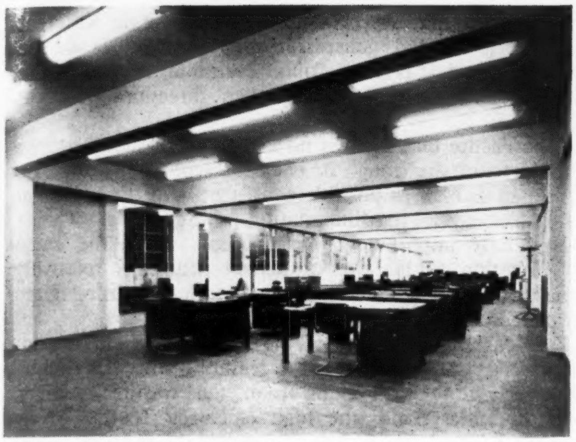


Fig. 1. Showing louvring effect of deep structural beams.

Fig. 4. An early example of "herring-bone" arrangement.

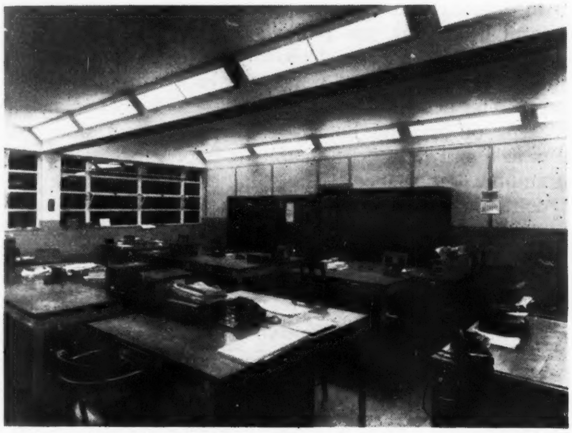


Fig. 2. Use of angle fittings necessitated by need to avoid heating panels recessed in ceiling.

Fig. 3. Effect of specular finish to ceiling.

of view also produces adverse effects on visual performance and comfort, although the effects are not similar. The effect on visual performance depends chiefly on the total intensity (i.e., candlepower) of the source towards the eye and is relatively little influenced by its brightness. The effect on comfort, on the other hand, is dependent both on brightness and intensity of the source. Thus a large source of low brightness may cause little or no discomfort, but may cause visual disability, and a small source of high brightness may cause no disability but may be distracting and uncomfortable. Lighting fittings should therefore be kept as high as possible above the general line of sight to reduce these adverse effects to a minimum.

From the above it is clear that there are three kinds of brightness relationships to be controlled :—

(a) Those on and immediately around the work.
(b) Those throughout the entire field of view.
(c) Those on and around the light sources.

The exercising of control on these points must therefore affect the choice of lighting fittings, decorations and, to a certain extent, furniture.

Lighting Fittings

The general classification of lighting fittings into certain main categories is well known.

In the direct lighting unit nearly all the light is emitted below the horizontal, and consequently the proportion of light directed on to the working plane is high; but if a room is lit entirely by such units the upper part is often dark and the shadows throughout the room are deep and harsh. The unlighted ceiling often contrasts unpleasantly with the objects on the working plane and still more with the unshaded parts of the units themselves. Thus are created many of the unfavourable conditions previously mentioned.

Indirect types of unit, throwing most of their light upwards, tend to produce excessively bright ceilings which can cause visual disability due to the working plane appearing to be poorly illuminated.

It is suggested that, in general, units of intermediate types between direct and indirect are most satisfactory for office lighting. It is obviously an advantage to

employ units which direct a large proportion of the light towards the working plane, but it is also important that a reasonable component is directed towards the ceiling and the walls. While the exact distribution is not critical, it is suggested that 50-60 per cent. be directed downwards, some 20 per cent. towards the walls, and 10-20 per cent. upwards towards the ceiling.

Units such as the familiar opal sphere give a distribution similar to that proposed above, but with the demand for higher illumination values and a consequent need for high wattage fittings, care should be taken to see that the units are not excessively bright. The same caution should be taken in selecting fluorescent fittings, for with the present brightness of MCF/U tubes glare is likely to be caused if the lamps are unscreened.

There is a demand for fittings which give very little light sideways but confine the emitted flux in upward and downward directions. This means that a working position is illuminated by fewer fittings than is the case with general lighting fittings, but the small loss in illumination from remote fittings is more than compensated by the removal of the glare which they tend to cause.

Lighting Installations

Reception rooms, entrance halls, inquiry offices and waiting rooms are often the visitor's introduction to a building, and provided they are not used by the staff for sustained work a moderate amount of discomfort glare can be permitted to achieve an effect of brightness and sparkle. For prestige value decorative fittings should be used.

In small private offices the artificial lighting should be designed in relation to the number of occupants and not to the floor area. Too often one central fitting is provided in a room occupied by two or more people, with the consequence that none of them has satisfactory lighting. If tungsten lamp fittings are used, two units on the diagonal of the room will ensure reasonable glare-free lighting on the desks; with fluorescent lighting, two fittings oriented symmetrically across the room are usually found to be suitable.

It is unlikely that tungsten fittings will be used in typing and computing offices in view of the high illumination demanded. In large typing pools, where the desks are arranged in rows and are not likely to be moved, a system employing angle type fittings illuminating each row from just behind the typists will do much to prevent reflected glare from the bright parts of the machines. Where the arrangement of desks is subject to frequent change, or where the workers are not all facing the same way, a " herring-bone " arrangement of fittings will ensure the most satisfactory lighting conditions at all times. Both of these systems may be considered a little unorthodox, and trough or enclosed fittings may be preferred. If this is the case, care should be taken in the choice of position for the units, and attempts made to arrange them above or a little behind the workers to avoid the reflected glare mentioned above. In offices where there is likely to be rearrangement a general lighting scheme is most satisfactory, providing attention is given to the spacing-height ratio to ensure that there is reasonable uniformity of illumination.

In general offices, as in typing pools, it is unlikely that tungsten lighting fittings will be used in view of the high level of illumination which is required. To cater for the fact that workers may be looking in different directions, a good general lighting scheme should be provided, and it is often found desirable to arrange the fluorescent lighting fittings in two directions at right angles.

To ensure that there is no view of bare tubes, fittings should be of the trough or enclosed type, and should be mounted as high as possible consistent with the provision of a reasonably even illumination on the ceiling. This is particularly important in large offices where the angle of elevation to the eye of distant fittings is relatively small and the likelihood of these fittings causing glare is increased.

So far as the colour of the fluorescent light is concerned, it is found that the " Natural " or " Daylight " lamp is more stimulating than the warmer colours. On the other hand, the high efficiency of the " New Warm White " lamp has increased its popularity for office use, and despite its stimulating effect, the daylight type is not very popular due to its colour rendering.

The switching arrangement should be such that sections of the lighting can be switched on to supplement the natural daylight wherever this is necessary.

In drawing and tracing offices the provision of a high uniform brightness, the avoidance of reflected glare and the elimination of edge shadows cast by the tee and set squares, protractors and scales are important considerations. The design of the installation will depend upon the type of drawing boards used; the correct siting of units to avoid reflections in tracing paper and linen is of paramount importance. The siting of fluorescent fittings in continuous lines at right angles to the benches will ensure that any reflections on the boards will be directed to the left and right of the draughtsman, while at the same time eliminating edge shadows from instruments no matter whether the man is left- or right-handed. There is much to be said for self-illuminated tracing boards in offices where this process is carried out continuously. The requisite brightness can be achieved locally, and the apparent contrast of the original drawing as seen through the tracing medium is increased. For comfortable working conditions, the brightness of the tracing should not exceed five times the surround brightness.

A minimum value of 1 lm/ft^2 on the treads of stairs or at floor level in corridors is recommended in " The Lighting of Office Buildings " (H.M.S.O. 1952), but in buildings where other rooms have illumination values between 15 and 50 lm/ft^2 it is felt that this value should be increased to about 5 lm/ft^2 to prevent the stairs and corridors from appearing under-lit. Corridors should be lit evenly and dark corners avoided and, as far as possible, lighting points should be sited near doorways. The appearance is improved if the walls are well lit, and fittings which give a large sideways component should be used. Fittings for lighting stairs should be arranged so that each tread throws a shadow covering between 25 and 75 per cent. of the width of the tread beneath.

References

(1) Lighting Committee of the Building Research Board. Post-War Building Studies. No. 30. The Lighting of Office Buildings. Appendix I. A Survey of Lighting in Offices. H.M.S.O. (1952).

(2) I.E.S. Code for the Lighting of Building Interiors (1949).

(3) Weston, H. C., and Taylor, A. K. The Relation between Illumination and Efficiency in Fine Work (Typesetting by Hand). Joint Rep. of Indus. Fatigue Res. Board and Illum. Res. Comm., D.S.I.R. H.M.S.O. (1926).

Lighting for Drawing Offices

By H. E. BELLCHAMBERS, A.M.I.E.E.*

Introduction

There have been considerable advances in drawing office lighting techniques during the last five or six years, a number of experiments have been made, and, although the lighting finally adopted has to some extent been conditioned by the size and structure of an office, the successful examples are very similar in form.

The advances we have seen are due to a number of causes, not the least of which is a better appreciation of the visual task involved in modern drawing office practice. Improved light sources and methods of light control and a clearer understanding of the factors determining visual comfort and efficiency have added greatly to the lighting engineer's ability to provide lighting installations that are efficient, comfortable and pleasing.

In making an appraisal of the lighting of a large office (which included a drawing office) in the U.S.A., C. J. Kuepel (*Illuminating Engineering*, March, 1951), in conclusion, complained that he found that while the literature available is clear on what the standards of quality and quantity should be, there was a serious dearth of published specific information on just what to do to achieve these standards. This still appears to be generally true of drawing office lighting, and the examples given here of good practice should help to eliminate this criticism.

Lighting Task

When planning a lighting installation where a specific task is involved, the nature of the task, the degree of concentration which it may entail, and the most suitable environment in which to perform it if fatigue and strain are to be avoided must be studied.

The task with which we are here concerned involves the drawing of lines with pencil or pen, using as a guide a straight or curved edge, the accurate measurement of distances and angles, the correct location of intersecting lines and the centring of drawing instruments. Many of the lines will be drawn with a fine, hard pencil, and this demands a high degree of visual acuity within a small field of view at close range, demanding continuous concentration for quite long periods.

In the report on the Lighting of Office Buildings, Post War Building Studies No. 30, Appendix IV, by H. C. Weston (H.M.S.O., 1952), the size and nature of the task in drawing offices is given; here "The critical detail was considered to be the intersection of centre lines and the important contrasts, those between fairly hard pencil lines and ordinary drawing paper, those between pencil lines as seen through tracing paper and the tracing paper itself, and the corresponding contrasts when tracing cloth is used." The visual angle of the task was measured and found to be between one and two minutes when the viewing distance is 13 in., whilst the contrast of pencil lines on drawing paper were medium, between 60 per cent. and 30 per cent., and when covered with tracing paper or cloth, contrasts were poor and below 30 per cent. In the I.E.S. Code the size category of this task is given as small to very small, and with the contrasts entailed in the work, demands a minimum illumination of 30 lm/ft². For many drawing offices an illumination on the drawing boards of

* Research Laboratories, British Thomson-Houston Co., Ltd., Rugby.

40 to 50 lm/ft^2 is desirable, while tracing offices may need up to 70 lm/ft^2.

From the foregoing it will be evident that the main requirement is a high level of uniform luminance at the drawing boards enabling the details to be resolved, and the elimination of harsh shadows from the working edges of tee squares, set squares, scales, etc. Reflections from the white paper, glazed tracing linen and polished scales, which may otherwise cause discomfort glare, must be avoided whenever possible. The work of the Building Research Station has clearly shown the importance of brightness contrast grading; it is of particular importance in drawing offices and must be carefully considered.

Installation Planning

At the present time there is no straightforward method available to illuminating engineers by which installations may be designed from a knowledge of desirable luminance values for the whole of the visual field and we must still largely depend upon the method of design based upon illumination for the task, choosing our luminaires from experience, and then having determined the number and type required apply some glare rating test as a check. From accumulated experience of a number of installations it is then possible to build up a code of good practice to guide installation design.

In a review of lighting for drawing offices published in *Light and Lighting* in June, 1947, L. C. Rettig pointed out the difficulties of using incandescent filament lamps if glare is to be avoided, unless completely indirect schemes are used and then cost usually made them prohibitive. Even in large offices using indirect schemes there is still the risk of glare being caused by a large area of bright ceiling viewed at a low angle, whilst compared with the ceiling luminance the drawing boards may seem poorly illuminated.

It is, however, interesting to note early American practice where cost seems to be a less important factor. There are many records of drawing office lighting in the United States where completely indirect incandescent filament lamp lighting was used, but the electrical loading per sq. ft. of floor area was high, and except in air conditioned rooms would cause discomfort in warm weather. With the introduction of the fluorescent lamp the tendency was to follow incandescent lighting practice and install indirect schemes, but these eventually gave way to general diffusing luminaires followed by more direct lighting with screening of the source and some upward light.

In this country we have arrived at much the same answer through a different route. The introduction of the fluorescent lamp gave an opportunity for higher levels of shadowfree lighting and the early installations in most cases followed industrial lighting practice using direct lighting from luminaires with industrial type reflectors. Some installations provided general lighting while others were localised general schemes. Many of these installations were a considerable advance on earlier methods but glare, although greatly reduced, was still a source of discomfort. A more general practice to-day is to use direct lighting with louvres to screen the source, and whenever possible, to use some upward light.

The American I.E.S. has drawn up recommendations for office lighting which include drawing offices. The recommendations cover illumination, luminance ratios between various parts of the visual field, maximum values of luminance for the luminaire in various zones and for the immediate surround to the source, and also surface reflectivities. These recommendations were considered at length by R. C. Putnam in *Light and Lighting*, December, 1952. In this country Post War Building Studies No. 30, already mentioned, indicated the most desirable characteristics for good drawing-office lighting.

Some draughtsmen have a preference for flexible local lighting because it enables them to direct light wherever it is most convenient, and very high levels of illumination are possible over a small area. From discussions with a number of draughtsmen who have had experience of both methods, this preference by some draughtsmen for a local light would seem to be because their earlier experience with general lighting schemes had not provided them with sufficient shadow-free illumination, and therefore the addition of a local light had improved the conditions. A

Fig. 1.

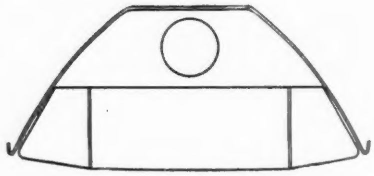


Fig. 2.

TRANSVERSE CUT-OFF 50° TO D.V.
LONGITUDINAL CUT-OFF 60° TO D.V.

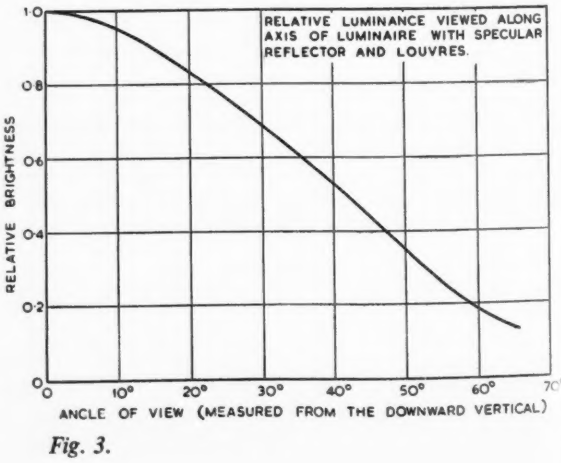


Fig. 3.

Fig. 4.

distinct disadvantage of the local light is the appearance of bright patches of light reflected in the white paper, which are a source of distraction and sometimes of discomfort to other draughtsmen.

The design of installations will depend upon the shape, size and layout of the office, and whether near-vertical or horizontal drawing boards are used. The general trend, as already mentioned, is towards fluorescent lamp reflector-type luminaires fitted with louvres and preferably providing some upward light, arranged in rows running parallel to the left- and right-hand edges of the boards. It has been argued that, because most lines that are drawn are either vertical or horizontal, shadowing can be more easily eliminated if the boards are at 45 deg. to the direction of the luminaires, either by turning the boards through 45 deg. or arranging the rows of luminaires at 45 deg. to the walls of the office and keeping the boards in the conventional position. This may be worth while in certain cases, but the extra room space required by the one method and cost of installation in the other are distinct disadvantages.

The working plane in a drawing office has a high reflection factor, and the inter-reflected light from this surface helps to provide the high environmental luminance which is essential. This is aided by the trend in drawing reproduction in the use of dyeline printing with black lines on a white background instead of blue printing with white lines on a blue background.

For tracing offices a back illuminated translucent screen of 100 to 200 ft.-lamberts luminance is very valuable where contrasts are poor. When the whole of the bright area is not being used the unwanted portion should be screened to prevent glare. An example of a small unit using six 2-ft. 20-watt fluorescent lamps is shown in Fig. 1.

The screening of light sources in the earlier fluorescent lamp installations was often restricted to that obtainable with the 70-deg. cut-off of reflectors, which has tended to become a standard for industrial lighting. However, if glare is to be eliminated much greater screening is necessary. The addition of a louvre system introduces a narrower intensity distribution requiring closer spacing to maintain uniformity of illumination. This involves higher installation costs and frequently it is difficult to persuade those responsible for the expenditure that it is really worth while. Fig. 2 shows a reflector fitted with louvres, which has proved to be very successful. The relative luminance distribution of this luminaire in a plane containing the axis is shown in Fig. 3; when "Daylight" lamps are used the luminance at 0 deg. is approximately 1,075 ft.-lamberts, and at 45 deg. it falls to 450 ft.-lamberts (i.e., approximately 1 cd. per sq. in.).

Installation Practice

The drawing office shown in Fig. 4 is a particularly interesting one. It is 100 ft. long x 20 ft. wide and 10 ft. high, and contains two rows of drawing-boards arranged so that the natural lighting enters the office at the draughtsman's left-hand side in each case. It had been noted during the day-time that troublesome specular reflections in polished scales and glazed paper were absent, and therefore it was decided to provide artificial lighting from angle luminaires above the windows so that the direction of the light was similar for both artificial and day-lighting conditions.

The daylight photograph shows the luminaires very clearly; 80-watt fluorescent lamps are used, the spacing between them being 7 ft. or approximately one luminaire per draughtsman. To prevent glare from the line of fittings, vertically slatted louvres are fitted. The top edge of the luminaire gives a satisfactory cut-off, the lamps are not visible from the other side of the room and hence horizontal louvres are unnecessary. Illumination on the drawing-boards is 30 lm/ft^2 with an average throughout the office of 22 lm/ft^2. The illumination from the fluorescent lamps falls off towards the centre of the room, in the same way as does the natural lighting and the level on the reference tables is from 15 to 20 lm/ft^2. The incandescent filament lamp lighting at the centre of the room was included to give additional light there and also to provide lighting for cleaners. An adequate illumination is provided on the drawing-boards whether used in the

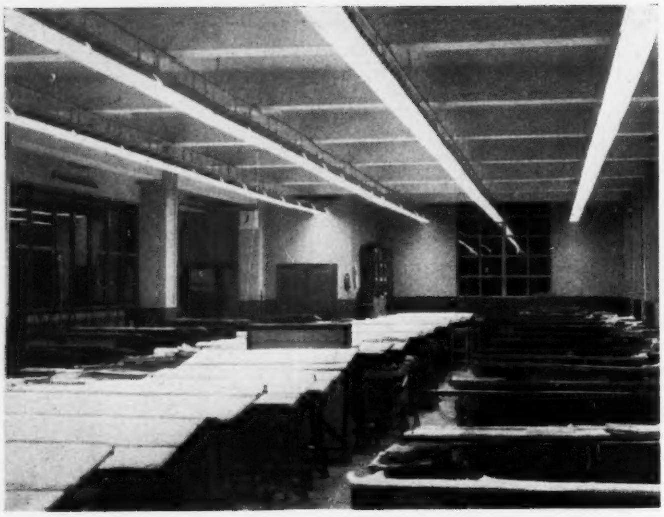


Fig. 5.

Fig. 6.

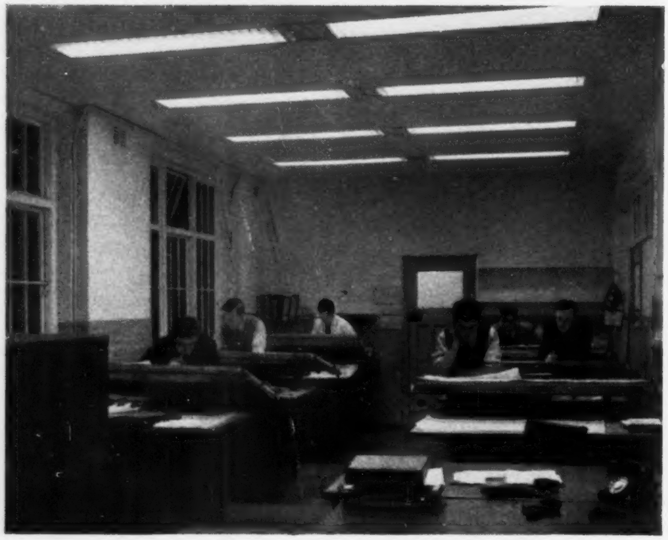


Fig. 7.

horizontal or vertical position, and glare is satisfactorily eliminated.

Figs. 5 and 6 are photographs of two very similar large offices, one taken in artificial light and the other in daylight. Each of the offices is 126 ft. long x 26 ft. wide, containing three rows of drawing-boards and reference tables. The lighting in each case is from four continuous rows of single lamp 5-ft. 80-watt fluorescent lamp luminaires with anodised aluminium reflectors and white stove enamelled louvres. The profile of the luminaire used in these installations is that shown in Fig. 2. Spacing between rows is 5 ft. 9 in., they are mounted at 7 ft. 6 in. above the drawing-boards and are positioned so that the light mainly comes from the left front of the draughtsman. An average of 45 lm/ft^2 is maintained over the near horizontal drawing-boards and the general surround luminance has an average value of 7 ft.-lamberts. The glare constant for these offices, determined by the Building Research Station formulae, classified the glare condition as "just acceptable" and draughtsmen working in these offices say that they are never conscious of any discomfort due to glare.

In the smaller office illustrated in Fig. 7, recessed louvred luminaires containing two 5-ft. 80-watt fluorescent lamps are flush mounted and therefore no light falls directly upon the ceiling. Illumination on the drawing-boards is 35 lm/ft^2 and the environmental luminance provides seeing conditions free from discomfort. The luminance values for various surfaces in this office are:—

	Luminance (foot-lamberts)
End wall above the door	4
Ceiling between luminaires ...	7
Luminaire louvres viewed at 45 deg.	50
Upper side walls	10
Lower side walls	5

It is interesting to note that although the ceiling does not receive any direct light, the inter-reflected light from wall surfaces with high reflectivities aided by light reflected from the white paper provides satisfactory seeing conditions.

A further example of an installation using louvred reflector luminaires and providing some upward light is given

in Fig. 8. Here continuous rows of two-lamp 80-watt luminaires are used over the drawing-boards, and they are spaced out over the reference tables. Again, light is mainly from the left front of the draughtsman and the illumination is 30 lm/ft^2.

Fig. 9 shows an example where ceiling structure has been used to provide screening of the light sources whilst avoiding excessive losses. Here the illumination provided is of the order of 60 lm/ft^2 and the environment luminance pattern provides excellent seeing conditions. Continuous rows of 120-milliamp. cold cathode tubing are placed at 30-in. spacing, and the deep louvres are triangular in section, coming almost to a point at the bottom.

Another example where an illumination of 30 to 40 lm/ft^2 is provided is shown in Fig. 10.

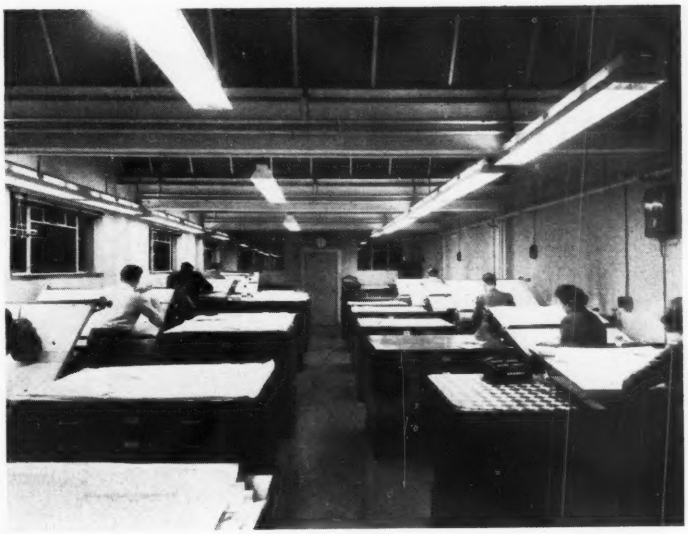


Fig. 8.

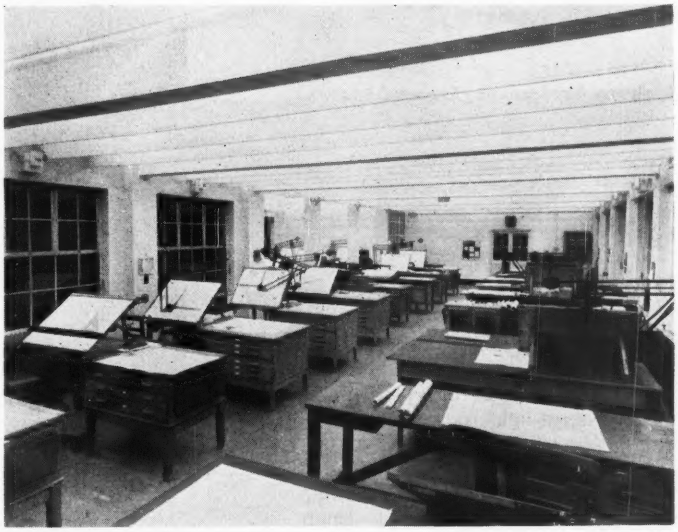


Fig. 9.

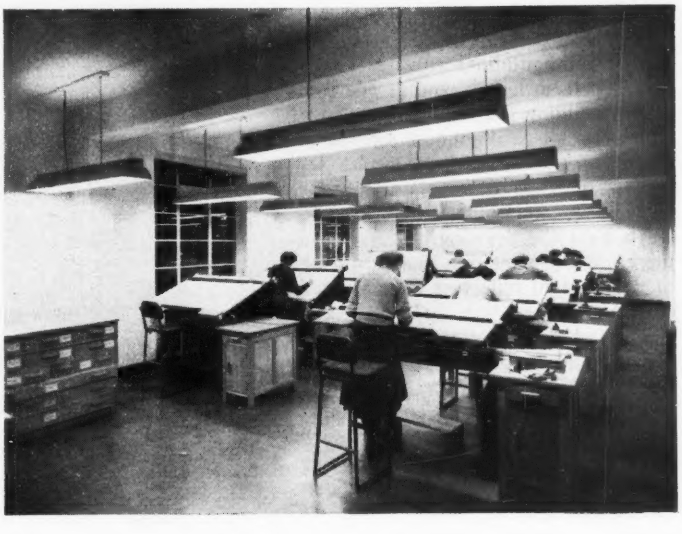


Fig. 10.

Conclusion

Lighting for drawing offices has in the past been of a higher standard, consistent with the need, than that met in general offices, and the importance and necessity of good lighting has generally been appreciated.

The examples given here show the trend in drawing office lighting techniques. Many installations could be improved, but cost is an important factor. It not infrequently happens that a stage of development is reached where the designer of lighting equipment is hard pressed to justify the use of a method of light control for which the cost is appreciable, while the corresponding increase in the value as a factor contributing to visual comfort and efficiency and leading to improved work, quality and output, is difficult to assess in monetary value. Thus, the introduction of worthwhile improvements is sometimes delayed.

Acknowledgment

The author wishes to thank Mr. L. J. Davies, Director of Research, B.T.H. Co., for permission to publish this article. Photographs and details of drawing offices are published by kind permission of the following: Fig. 4, Imperial Chemical Industries Ltd., Billingham Division; Figs. 5, 6 and 7, British Thomson-Houston Co., Ltd.; Fig. 8, Crompton Parkinson Ltd.; Figs. 9 and 10, General Electric Co. Ltd.

Some Recent Office Lighting Installations

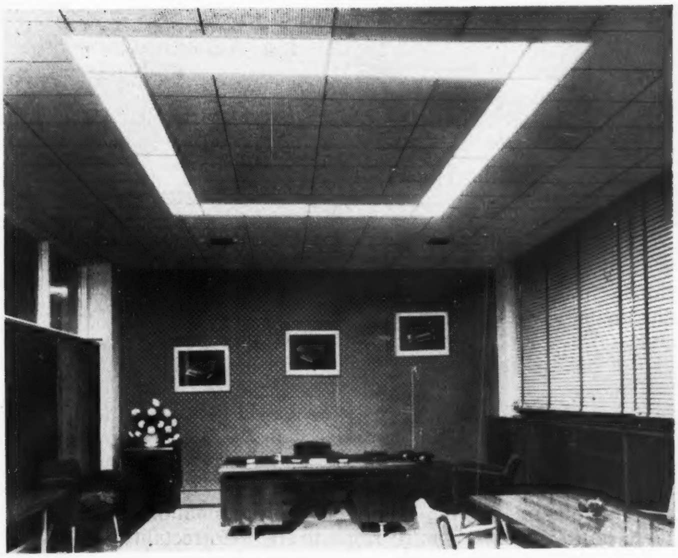
Morris Tractors and Transmissions, Birmingham

Lighting Equipment : General Electric Co., Ltd.

A section of this factory was converted recently for use as a works office and drawing office. New fluorescent lighting was installed at the same time, and as the premises have a north-light roof it was found convenient to use a trunking system rather than individually suspended fittings. The lighting trunking employs a combination of chain suspension and direct clamping to trusses; vitreous enamel reflectors are attached to it at 7 ft. 6 in. centres. The five longitudinal runs are each over 200 ft. in length, and at one side of the building the reflectors are at a wider spacing to illuminate individual offices, on the basis of one fitting per office. Average illumination over the general area is 17 lm/ft^2.

To light the drawing office section there are ten transverse runs, on each of which eight reflectors are mounted end to end.

The whole installation comprises 228 single-tube luminaire with 5-ft. 80-watt 'Natural' fluorescent lamps. Instant start gear is accommodated inside the trunking adjacent to each fitting and is accessible by removing cover plates. Mounting height throughout is 11 ft. 6 in.



A. C. Delco Division, General Motors, Southampton.

Architects: Howard, Souster and Fairbairn.

Contractors: John Hearson and Co., Ltd.

Lighting Equipment: The Edison Swan Electric Co., Ltd.

This new office block is an example of the application of modern trends in fluorescent lighting to offices. To meet the varied requirements of private offices, general offices and drawing offices three different forms of lighting are provided. In the managing director's office a subdued but exhilarating colour effect is achieved by the use of low-toned papers, one green, one red, contrasting with white Venetian blinds with an acoustic tile ceiling which helps to create an effective balance between matt and shiny surfaces. A hollow square laylight panelled with diffusing glass is fitted flush with the acoustic tile ceiling. The panels conceal eight 125-watt 8-ft. 'New Warm White' fluorescent lamps which gave an initial intensity measured at table level of 75 lm/ft^2. Separate switching provides three lower levels of illumination.

For the general office individual recessed reflectors each for one, two or three 80-watt 'New Warm White' fluorescent lamps were used, giving an initial intensity of 30 lm/ft^2 on the working plane. Detachable louvres and detachable internal panels in the reflectors allowing access from below to all components ensure minimum maintenance costs.

For the drawing office it was decided to use cold, cathode lighting. Four lines of tubes at 120 mA in continuous recessed reflectors with detachable louvres gave an initial intensity on the working plane of 75 lm/ft^2.

In both the general office and the drawing office the lighting system was designed to allow free use of temporary partitioning which can rise to ceiling height to form private offices.

De Havilland Engine Co., Ltd.,
Leavesden Aerodrome.

Designed by: Holophane, Ltd., and De Havilland Engine Co., Ltd.

Lighting Equipment: Holophane, Ltd.

The entrance hall, private and general offices are among the sections of these new offices which are illuminated by means of Holophane tungsten lighting units. Circular "Controlens" units have been recessed into the ceiling in the entrance hall, and have been continued under the entrance canopy for exterior lighting; an illumination of 16-18 lm/ft^2 is provided at desk level inside the hall.

The general offices on the ground floor, south and east wings, are lit throughout by 200-watt "Correctalite" luminaire, giving a level of illumination of 17-20 lm/ft^2 and 16-17 lm/ft^2 respectively. "Correctalite" is a slightly tinted blue prismatic glass which gives partial colour correction to the tungsten lamp, blending in more naturally with daylight and giving a better black-white definition. Tungsten lighting has also been installed in directors' and senior executive offices, dining-room, stairways and corridors.

Robert Boby, Ltd.,
Bury St. Edmunds.

Lighting equipment: Siemens Electric Lamps and Supplies, Ltd.

One of the chief requirements of a lighting scheme for any modern drawing office is uniformity of illumination. Though some draughtsmen still retain the local light over their drawing-boards, on the whole they now appreciate that the contrast between a brightly illuminated working area and the comparatively dim surroundings is one of the major causes of fatigue. In this drawing-office 4-ft. industrial type luminaires are used to give a high general illumination throughout the office and on the drawing-boards. The luminaires are individually controlled by drop cord pull-switches.

Ferranti, Ltd.,
Edinburgh.

Architects (Research Lab. and Drawing Office): Fairbrother, Hall and Hedges.

Contractors: William Allan Smith and Co., Ltd.

Lighting Equipment: The Edison Swan Electric Co., Ltd.

The main office and buying department of the Edinburgh factory of Ferranti, Ltd., was recently reconstructed and a new Electronics Research Laboratory and drawing office recently opened.

The lighting fittings in the drawing office could not be fixed to the underside of the ceiling beams as the metal and glass partitioning which divides the laboratory and drawing offices into sections fits closely under the beams and may be repositioned at any time to accommodate larger or smaller teams of workers on particular projects; neither could the fittings be secured to the actual ceilings, which incorporate panel heating equipment. A special type of louvred "Perspex" diffuser fitting was evolved for side mounting on continuous channelling running along the side of the ceiling beams and on the walls. End plates, with brackets inside to receive the control gear channel, are bolted to the channelling which contains the wiring. The lamp is inserted, a louvre slides into the base of the end plates and a "Perspex" diffuser panel slides into position at the front of the fitting. Snap-on cover plates conceal the channelling in the spaces between the fittings.

The fittings each house one 5-ft. 80-watt fluorescent lamp, but can be adapted to two-lamp units by adding extra control gear and lampholders. Similarly, the spacing between fittings can be altered by repositioning on the channelling and refitting cover plates.

In the main office and buying department 5-ft. open-ended trough reflector fittings are used. The fittings are suspended from a hung ceiling of plasterboard; adjacent fittings are linked by conduit and the wiring is carried through each fitting. The illumination throughout the offices is over 30 lm/ft^2.

Wickham, Ltd.,
Coventry.

Architects : W. S. Hattrell and Partners.

Lighting Equipment : The General Electric Co., Ltd.

Entrance hall

This office building replaces premises damaged by fire. Fluorescent lighting has been installed throughout the building, which has been designed in modern style.

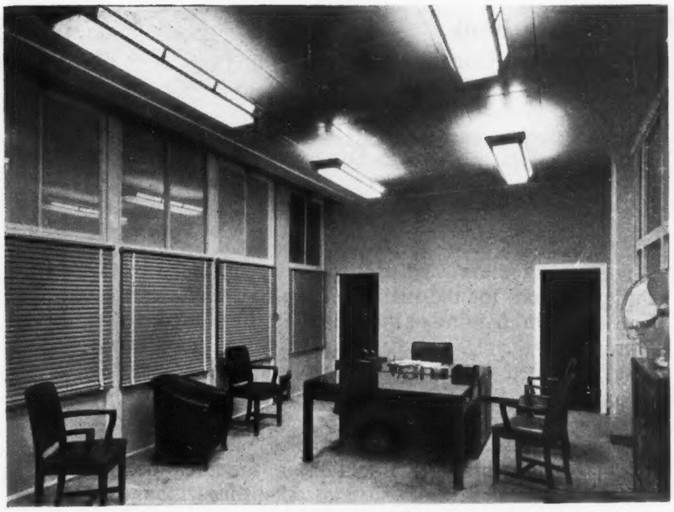
The luminaires comprise trough reflectors for the general and drawing offices, and various decorative designs for private offices and the entrance hall. All rooms have Frenger acoustic heated ceilings; the luminaires are tube-suspended from conduit boxes fixed to the concrete upper floor. Decorative bosses are fitted where the rods pass through the Frenger panels. " Natural " 5-ft. 80-watt lamps are used throughout the installation.

The general offices are lighted by four rows of single-tube reflectors, slotted to give upward lighting. In these offices the ceiling height is 10 ft. 6 in., and the mounting height of the luminaires is 10 ft The rows of luminaires run longitudinally except in the drawing office section of one main office area, where they are arranged trans-

versely and parallel with the drawing boards to suit structural requirements.

In the entrance hall are four decorative twin-tube luminaires with cream enamel bodies, luminating glass side panels, and polystyrene louvres. Two tungsten brackets with satin silver metalwork and champagne glass, each housing two 60-watt lamps, are mounted on a column under the main staircase at the back of the hall to avoid a contrast between this portion and the main area with direct illumination from the fluorescent fittings. The luminaires in the managing director's office are two-light decorative pendants with body finished pale beige, gilt suspension rods and polystyrene louvres.

An analysis was made before work began of comparative costs of fluorescent and tungsten lighting to provide the desired average service illumination of 12-13 lm/ft^2. Taking for an example a 150-ft. by 30-ft. general office area, it was found that although the capital cost of the fluorescent scheme was about £150 higher, the annual running cost (for current and replacements) was £31 10s. for fluorescent lighting, against £89 for a tungsten installation, so that the higher cost for the fluorescent scheme would be offset in three years' service.



Managing Director's office

One of the main offices

Drawing office

Westminster Bank, Lombard Street.

Lighting Equipment: George Forrest and Sons, Ltd.

The redecoration of these premises included new lighting schemes for the main banking hall and clearing rooms. General lighting in the main hall (illustrated here) is provided by 22 9-tube cold cathode fluorescent fittings mounted level with the acoustic ceiling, giving approximately 25 lm/ft^2 on counter and desk positions. Triple-tube cold cathode fittings arranged in rectangular form around the dome at the staircase end of the hall provide supplementary illumination in the area below the dome. A number of incandescent fittings mounted on the perimeter walls of the hall introduce interest into the scheme and reduce ceiling contrast.

South of Scotland Electricity Board, Glasgow.

Consulting Engineers: Ramsey and Primrose

Installation: James Kilpatrick and Son, Ltd.

Lighting Equipment: Lumenated Ceilings, Ltd.

This installation, a typing pool, is an example of the luminous ceilings, now gaining in popularity in this country, consisting of corrugated translucent vinyl sheet supported on a light steel framework beneath the light sources, fluorescent or tungsten, which can be mounted direct on to the structural ceiling above. In this case the light sources are 5-ft. 80-watt 'New Warm White' fluorescent lamps; the average illumination on the desks is 35 lm/ft^2.

Loewy Engineering Co. Ltd., Poole.

Architects:
Farmer and Dark, F/F.R.I.B.A.

Lighting Equipment: Ekco-Ensign Electric, Ltd.

The architects for this new building used in the drawing offices the fluorescent luminaire designed by the Building Research Station and developed and produced by Ekco-Ensign Electric, Ltd.

The complete unit comprises a ceiling box containing control gear, spine, coloured transverse metal louvres, diffusing opal 'Perspex' side screens and a single 80-watt 5-ft. 'White' 3,500-deg. K fluorescent lamp. This luminaire has a high efficiency with low brightness and is light of weight. The architects decided to suspend the spine from the ceiling box by means of piano wires; the standard suspension is by means of twin ½-in. dia. chrome rods. The level of illumination on the drawing boards is 30 lm/ft².

Clarke, Chapman & Co. Ltd., Gateshead.

Installation: Cairns (Newcastle), Ltd.
Lighting Equipment: E. N. Mackley and Co.

In planning the lighting layout for these new drawing offices special attention was given to the necessity of obtaining an installation where the light distribution would be even, and the overall illumination adequate for the preparation of drawings involving fine detail.

With a view to obtaining an installation of such a standard, it was decided to depart from the generally accepted type of luminaire incorporating a straight fluorescent lamp and to use the "Dunelm" 80-watt industrial circular fluorescent luminaire which gives a very even light distribution over a wide area. By using this type of luminaire it was found that a spacing could be achieved giving a balanced illumination and complete absence of shadow on the drawing board.

"Transtar" instant start control gear is used with an 80-watt 'White' 3,500-deg. K circular fluorescent lamp.

The mounting height is 9 ft. above the floor, the resulting illumination on the drawing board being 50 lm/ft².

De Havilland Aircraft Co. Ltd., Hatfield.

Architects: James M. Monroe and Son.

Installation: Electrical Installations Ltd.

Lighting equipment: Philips Electrical Ltd.

In these new drawing offices great care has been taken to make the fullest possible use of natural daylight. As the number of working hours during which artificial lighting is required is rather small, it was decided to install general lighting, supplemented by local lighting where necessary. "Windsor" fittings with the new 300-watt internally bowl-silvered lamps are used, this being the first installation to employ this new, indirect system on a large scale. The relatively wide spacing permissible with this type of fitting eliminated the need for a large number of points which could easily have been unsightly in this large interior. The ceiling panels are for natural lighting.

'Birmingham Post and Mail,' Birmingham.

Lighting equipment: Crompton Parkinson, Ltd.

The main front office at these premises in New Street has recently been reconstructed and a new combined fluorescent and tungsten lighting system installed. The office is a capacious one, with tall plate-glass windows overlooking the street, and is employed principally for the reception of callers and for the paper's advertising department services.

Fluorescent luminaires with reeded "Perspex" side panels were supplied for the main ceilings, six for the central ceiling, each housing four 5-ft. lamps, and 12 for the ceilings of the side and end aisles, each housing two 5-ft. lamps. The illumination at desk level from the general lighting system is 25-30 lm/ft^2. Local illumination over writing desks located in alcoves down each side of the room is provided by 75-watt spotlight reflector lamps behind panels of Chance "Spotlyte" glass.

An Electrical Ceiling Installation

Description of an installation for the Douglas Aircraft Co. in California.

By T. D. WAKEFIELD*

Seven services necessary to the Engineering Division of Douglas Aircraft Co., Inc., El Segundo, California, U.S.A., are furnished by an electrical ceiling in rooms up to 210 ft. square. The multi-functional ceiling provides: illumination of about 100 ft.c., fully diffused for comfort; noise control by acoustical baffles; power for electrically operated office machines; telephone services; fire protection by sprinkler system; conditioned air, distribution and return: and the outlets for the public address system. The corrugated plastic light-diffusers also conceal the pipe and ducts necessary to some of these services and they eliminated the usual expense of finishing the structural ceiling.

These multiple services are provided to the large engineering-drafting room areas and 13 private offices of different sizes. The cost of the two-storey steel and concrete engineering building was two million dollars. Its principal use since opening in mid-'54 is the designing of supersonic jet planes for the United States Navy. The personnel in the building is about 1,500 and the building provides each person a minimum of 75 sq. ft. of working space.

There was no precedent for installing this seven-service electrical ceiling, which evolved from the original Wakefield ceiling which is primarily for light and secondarily for acoustical control. The general contractor used steel pans on which the cement slab roof was poured. Before pouring, the electrical contractor drilled these pans to hold the steel inserts or bolts from which the entire ceiling is suspended. These preset inserts were placed with a nut on the top of the steel form and one beneath. When the concrete had set, the bottom nut was removed so that the form could be taken down. This left about ½ in. of the bolt exposed below the concrete roof slab. The Wakefield ceiling brackets were attached to carry the support rod for the lighting channel assembly.

These preset inserts saved many hours of installation. The contractor had received a drawing from the factory in Vermilion, Ohio, showing the exact spacing. The workmanship on the job was so well handled that not one of these inserts was placed incorrectly.

The corrugated plastic light diffusers are supported on a structural framework suspended from the lighting channel housings, which carry a total of 3,844 8-ft. lamps, 89 6-ft. lamps, and 46 4-ft. lamps, in all about five miles of light source.

The seven-function ceiling was considered originally be-

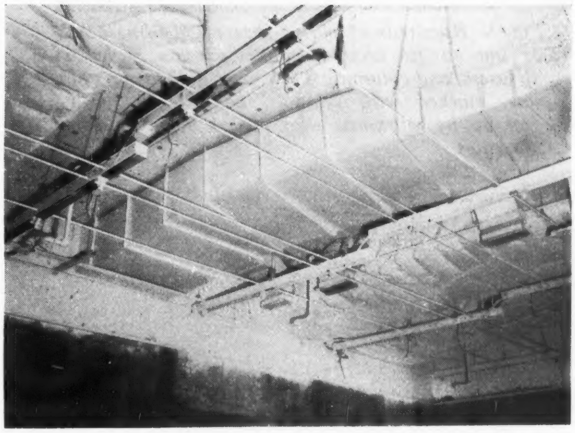


Fig. 1. Early stages, showing maze of piping, ducts, channels, all co-ordinated in advance. Sprinkler system pipe, upper centre, passes over and under lighting channel. Ceiling frame work, suspended from lighting channels, will be bolted to metal wall angles for rigidity.

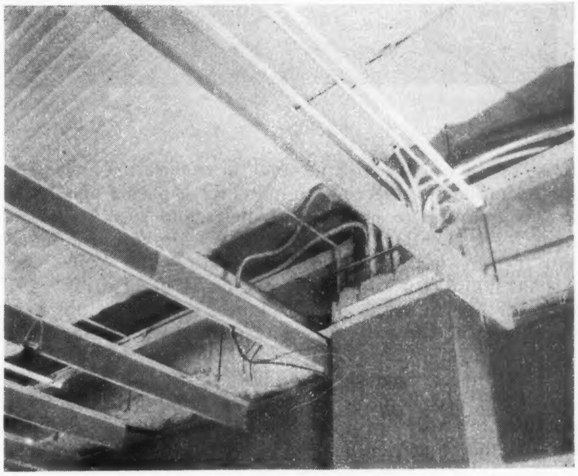


Fig. 2. Showing acoustical baffle rails resting on wall angles. Power wiring carried in bottom of rails. Electrical distribution panel is on lower part of column.

* President, Wakefield Lighting Limited, London, Ontario, Canada.

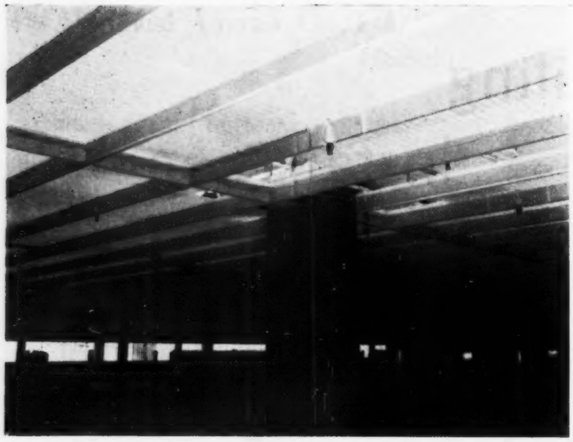


Fig. 3. Hundreds of plastic sheets had to be notched or cut to fit around public address outlets, air diffusers, and columns. They were pre-cut by a band-saw, marked with symbols, and placed for easy pick-up by workmen who placed them by symbol markings.

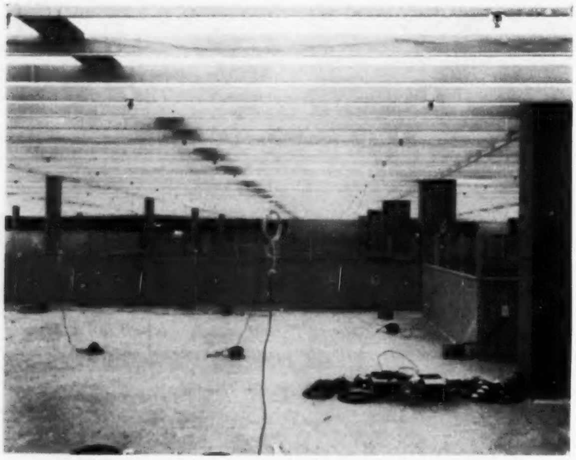


Fig. 4. On acoustical baffle in foreground, see telephone wires carried along baffle.

Fig. 5. The plastic ceiling's brightness is only 150 ft.-lamberts, but beyond the third baffle it drops to 50.

cause of the need of high intensity in engineering and drafting operations, where equal importance is placed upon light quality in order to eliminate shadows and specular reflections. The lighting was designed to provide an initial 110 ft.c. by using 1,800 8-ft. standard white (3,500 deg. Kelvin) fluorescent lamps, mounted on 36-in. centres. The need for high intensity low brightness light could not have been met with the same expenditure for power by any other means of lighting.

Light metal acoustical baffles suspended below the corrugated plastic diffusers not only fulfil their acoustical purposes but also furnish shielding for the translucent ceiling. In the large areas (210 ft. x 210 ft.) the personnel face perpendicular to these baffles and the maximum brightness which they see is between 50 and 60 ft.-lamberts, almost ideal seeing conditions. At no point are the diffusers themselves more than 150 ft.-lamberts.

The perforated acoustical baffles are on 3-ft. centres with cross baffling every 30 ft. There are more than five miles of these baffles in the building. Persons working 20 ft. apart are hardly conscious of other voices because of these acoustical controls.

Because the large flat roof is used as a landing place for helicopters, it was necessary to control this outside noise. Acoustical treatment was furnished by covering the concrete ceiling slab with thick acoustical tile.

The Douglas engineering operations demand use of much electrically operated office equipment. Power for 150 electric typewriters, 75 calculators and other electrical equipment, including photographic, is carried by wire mould with outlets in 6 ft. centres. The wire mould is mounted on the bottom of the acoustical baffles. Power is provided each 9 ft. for the full width of the large engineering rooms. Distribution wires are dropped to the office machines where needed, thus furnishing an unusual flexibility for power distribution.

This same condition applies to the telephones located throughout these enormous rooms. The telephone wires are run along the sides of the acoustical baffles in white cable. When necessary to run telephone wires perpendicular to the main baffles, holes were provided at the top of the baffle. All of the telephone wires eventually disappear into three large distribution panels located in supporting pillars in the centre of the engineering rooms.

With power and telephone wires suspended from the ceiling it might seem that the effect would be a web of wires. On the contrary one is hardly conscious of them because the brightness of the white wiring and the ceiling are so near to each other that the wires are hardly visible against the light coloured walls. When necessary to change telephones to another desk or area a service man uses a hooked pole to lift off the telephone wires from the baffle and in that way can change circuits or make other changes without using a ladder.

The 1,024 sprinkler heads are located on 9 ft. x 10 ft.

Fig. 6. Part of the finished job. Note that suspended power and telephone wires are hardly visible.

Fig. 7. One of the conference rooms in which acoustical baffles were omitted.

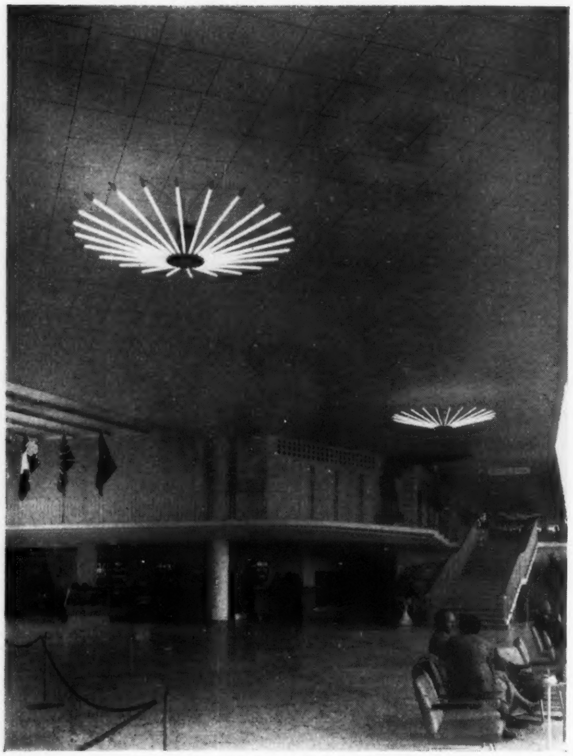
centres integrated into the acoustical baffles as shown in the photographs. It took a high degree of co-operation and co-ordination among the various trades represented to install seven services without interfering with another one. The fire protection pipes installed upon the structural ceiling were located so that they did not conflict with lighting channel wiring or air ducts. The excellent co-ordination in construction was due to the fact that the building owners, engineers, and architects gave the electrical contractor a central responsibility for the entire ceiling work.

Because of the location in southern California, where temperatures may range high in summer, air conditioning was very important. Each mechanical computer used by the engineers generates enough heat for a five-room house in a British winter. The distribution system consists of rectangular outlets 14 in. x 36 in. on 12 ft. x 30 ft. centres. They are arranged in groups of two outlets placed end-to-end at each location, to provide a total of 300 air distribution outlets on each floor. The air conditioning system of 450-ton capacity provides 12 complete air changes hourly, either warm or cool air, and its return.

One hundred loud speakers on 30 ft. x 30 ft. centres are recessed into the ceiling to provide inter-communication throughout the building. The 13 private offices are included in the multi-service plan with the exception of acoustical baffles not need in these smaller areas.

It was the intention of chief engineer Edward H. Heinemann and his associates to provide in this building an overall climate for efficiency, which of course includes comfort of employees. Mr. Heinemann had learned that a chief difficulty in a large company is the turn-over of personnel, representing a heavy expense in training, therefore the intent was to provide the two basic requirements for this type of work, comfortable temperatures and adequate and comfortable lighting. The building also furnishes plenty of elbow room and excellent noise control.

Kloten-Zurich Airport Terminal



The "Temple of Tourism."

The road to and from the airport divides into two, an upper ramp leading to the central departure hall on the first floor and a lower road at ground floor level by which passengers arriving by air leave for Zurich. Passengers arriving to catch planes pass through the central departure hall and descend to the customs hall, after which they are called to their planes or in the meantime can pass the time in the passengers' restaurant. Ample facilities are provided for spectators to visit the airport and a separate restaurant is provided for their use.

For the interior lighting the guiding principle was that all rooms used for administrative or technical matters, and for the clearance of passengers and their luggage, should have fluorescent lighting, whilst all rooms used for the accommodation and entertainment of air passengers and for social affairs should be lit with tungsten lamps.

Passengers' Hall

This hall is structurally and operationally in three parts: the entrance from the approach ramp; the middle portion, which has the appearance of a shopping street with the information and clearance offices of the different air lines on the right, while in a row on the left are the shops, post office, bank, etc.; in front, towards the runway, the passenger hall widens out to form an imposing "Temple of Tourism" having tall glass walls with free vision over the runway. From this wider part of the hall access is obtained to the restaurants, terrace, administrative building, the customs hall, and the runway. The lighting of the entrance portion is provided by simple ceiling-mounted fittings for 40-watt fluorescent lamps, each covered with a plastic grille. The mean illumination is about 18 lm/ft^2. In connection with this, mention may be made of the aluminium awning over the entrance, on the inclined corrugated sections of which are mounted high-tension fluorescent tubes directed towards the entrance; these provide roughly the same illumination as that in the interior. The "shopping street," the centre part of which is covered with a glass roof while the bureaux and shops run respectively left and right under a gallery, receives its lighting primarily from two rows of 40-watt fluorescent lamps mounted above the glass roof. These fluorescent lamps are in reflectors which cause the light to fall obliquely on the glass roof, and they are at such a distance that the roof appears as a uniformly bright surface. Over the bureaux there is a continuous line of the same lamps mounted on the ceiling and covered with "Perspex" screens. Each bureau has, in addition, its own local lighting. There is also a continuous line of lamps on the shop side to provide general lighting; this is screened from the central

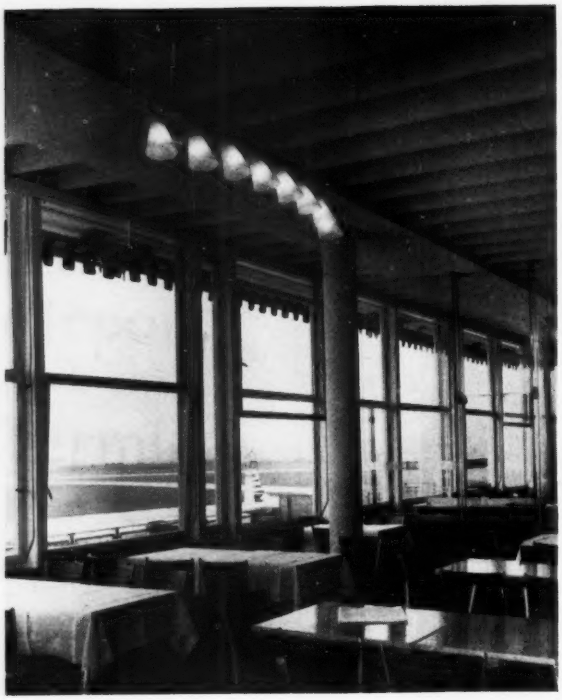
Transit waiting-room.

Bar

area by a simple perforated metal screen placed on one side only.

The average illumination in this part of the hall is about 8 lm/ft^2 from the roof lighting above and 11 lm/ft^2 when the under gallery lighting is also in use. In addition there is a certain amount of lighting from the shops themselves.

The "Temple of Tourism" (Fig. 1), which is two storeys high, derives its main lighting from two luminaires, each of which consists of 24 40-watt fluorescent lamps arranged in the form of a star. In their design these luminaires represent a combination of planned decorative



Passengers' restaurant.

Conference room.

effect and severe technical form. The average illumination in this area is about 18 lm/ft².

Business Rooms

The staircase leading from the passenger hall to the transit waiting hall, the customs hall and the runways, is lit by two parallel cold cathode tubes following the line of the stairs. The customs and departure hall on the ground floor and the luggage hall in the basement, as well as all the offices and clearance rooms connected with them, are lighted with standard fluorescent lamps in fittings of the simplest construction, either open or with shades. The rooms of the office section connecting on one side with the central building are lit throughout with fluorescent lamps, not after a uniform pattern but in accordance with the varying requirements of the occupants. The average illumination in the offices and the business room is between 25 and 35 lm/ft².

Assembly Rooms and Restaurants

With the object of creating an immediately obvious distinction between the business and assembly rooms the latter are lit with incandescent lamps. On the ground floor under the passenger hall is the transit waiting hall (Fig. 2), which contains a restaurant-bar, the post office and some sales stalls, and this is lighted by four 20-lamp " spider lanterns " and a large number of wall and column brackets. Above the bar counter (Fig. 3) and the restaurant seats further lamps and reflectors are fitted. All these luminaires are of contemporary style and are made of light metal or brass. The first and second floors of this wing each contain a restaurant. In accordance with the wishes and intentions of the owners and architect the lighting system of the restaurant on the first floor is, like all the internal equipment, very simple: metal fittings with a little ornamentation in brass and closed underneath with a " Perspex " grille. At certain places, especially in the rooms on the north-east, these are supplemented by wall fittings.

On the second floor are the so-called " passengers' restaurant " and the conference hall. Their fittings are on somewhat more luxurious lines. For lighting the restaurant Murano glass bowls of the " Rugiada " type have been used. They are used as ceiling lights, eight at a time in fan-shaped groups, projecting from the somewhat inclined ceiling on the side nearest the window (Fig. 4). On the opposite side and on the transverse walls they are supplemented by three-light wall brackets with similar but differently shaped bowls. Each bowl contains a 60-watt tungsten lamp with inner diffusing bulb. The large conference room (Fig. 5), which is at the same time a reception hall for official guests, is lighted by an oval-shaped 24-light chandelier on hexagonal steel tube, with brass fittings and heavy ground and polished crystal glasses. In the small meeting room a modern three-light chandelier is placed over the lecture table and this gives the room a marked feeling of intimacy.

The distinction between fluorescent and tungsten lighting for the business rooms and those used for social purposes has been abandoned on the two terraces which are built out from the restaurants with a view over the airfield. On these the lighting is provided by high-tension fluorescent tubes following the lines of the building, but their colour is matched as far as possible with that of the tungsten lamps.

The 1-kw. MA/H Mercury Discharge Lamp—

Application and Economics

By L. H. HUBBLE, F.I.E.S*

For more than a decade the British Thomson-Houston Company has carried out research on the horizontal operation of 250-watt and 400-watt mercury discharge lamps (type MA/V) for industrial interiors. This policy was adopted owing to the inefficient utilisation of these mercury lamps when used vertically in enamelled reflectors.

The argument for horizontal operation has been postulated on numerous occasions and lies in the two facts that (1) A long arc placed vertically in a reflector having a 20-deg. cut-off emits only about 18 per cent. of its light direct, and the remainder is subject to poor optical control with multi-internal reflections. This results in low efficiency (about 60 per cent.) for clean reflectors, and even small deposits of dust on the reflecting surfaces cause serious depreciation. (2) The same arc operated horizontally and cut off at the same angle gives nearly 40 per cent. direct light, and the remainder is subject to accurate optical control in the vertical plane giving efficiencies of about 75 per cent. and subject to much lower depreciation in use.

Since these mercury discharge lamps are used largely in medium and heavy industry, and at comparatively great mounting heights, it is frequently necessary to provide 40,000 lumens or more from each lighting unit. A well-known fitting of this kind (Fig. 1) has been extensively employed in steel works and elsewhere, using two 400-watt MA/V lamps giving 28,800 lumens and augmented with 1,000 watts of tungsten giving another 17,800, making a total of 46,600 lumens.

As all buildings in which blended lights are used are not necessarily very high a range of fittings is required, and that shown in Fig. 1 has been superseded by a system of component fittings which can be conjoined to produce from 12,000 lumens using a 250-watt MA/V and one 300-watt tungsten lamp, to 57,000 lumens using two 400-watt MA/V and one 1,500-watt tungsten filament lamp (Figs. 2 and 3).

*Lighting Department, The British Thomson-Houston Co., Ltd.

Since so many installations required the twin 400-watt assembly it was natural that thought should be given to a single larger wattage lamp, and the manufacture of a mercury lamp of, say, 1,000 watts to be operated horizontally and, preferably, without magnetic arc deflector was considered.

The new 1-kw. MA/H lamp (Fig. 4) was the result and in addition to not requiring any arc deflector it has exceeded expectations in light output, in simplicity, and in cheapness. The economic advantages of this lamp depend upon its horizontal operation, and, compared with the existing 1-kw. MB/V lamp—a more efficient lamp intrinsically—it shows up exceedingly well. (See Table 1.)

Many engineers do not like the high operating voltage of the MB/V lamp, and, owing to the more efficient horizontal operation of the MA/H lamp, it is claimed that no advantage is gained from the higher intrinsic efficiency of the MB/V lamp.

It is, thus, more interesting to compare the new 1-kw. MA/H lamp with the two or more 400-watt MA/V

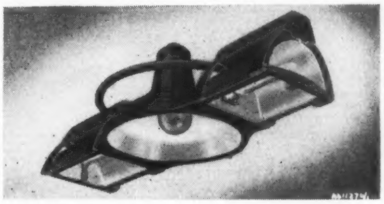


Fig. 1. Blended light fitting; two 400-watt MA/V and one 1,000-watt tungsten.

Fig. 2. Blended light fitting; one 250-watt MA/V and one 1,000-watt tungsten.

Fig. 3. Blended light fitting; two 400-watt MA/V and one 1,500-watt tungsten.

TABLE 1

Lamp	Operating voltage	Average lumen output	Reflector efficiency per cent.	Useful lumen output	Price
1 kw. MB/V	400/440	50,000	60	30,000	£8 0 0d.
1 kw. MA/H	200/250	40,000	75	30,000	£5 10 0d.

TABLE 2

Lamps	Average lumen output	Horizontal reflector efficiency per cent.	Useful lumen output	Price
3 x 400 w. MA/V	43,200	75	32,400	£8 17 0d.
1 x 1 kw. MA/H	40,000	75	30,000	£5 10 0d.

TABLE 3

Lamps	Cost of fitting	Cost of control gear	Total	Initial cost of lamps
(i) 3 x 400 w. MA/V	£18 0 0d.	£25 17 4d.	£43 17 4d.	£8 17 0d.
(ii) 1 kw. MA/H	£11 10 0d.	£17 19 8d.	£29 9 8d.	£5 10 0d.
(iii) 1 kw. MB/V	£14 5 0d.	£17 15 6d.	£32 0 6d.	£8 0 0d.

Fig. 4. The new 1-kw. MA/H lamp.

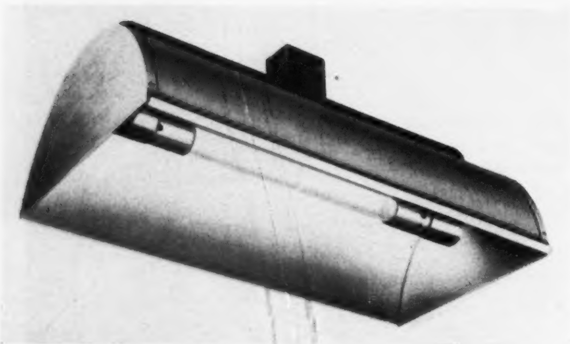


Fig. 5. Trough reflector fitting for use with 1-kw. MA/H lamp.

Fig. 6. The first installation using the 1-kw. MA/H lamp, with 1,000-watt tungsten lamps. The Steel Company of Wales, Trostre.

lamps it was designed to supersede. The nearest direct comparison is between three 400-watt MA/V lamps and one 1-kw. MA/H as in Table 2.

This is, of course, not the whole story, since the capital cost and maintenance of fittings must be taken into account and also that of control gear.

Table 3 compares the list price of three 400-watt MA/V fittings with that of the 1-kw. MA/H fitting (Fig. 5) and 1-kw. MB/V fitting.

To bring line (i) into parity, the prices of fitting and control gear should be multiplied by 30/32.4 (i.e., ratio of useful lumen output) giving approximately £40 11s.

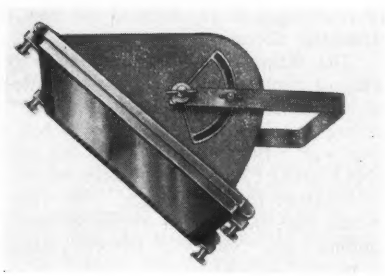


Fig. 7. Floodlight projector for use with 1-kw. MA/H lamp.

Exterior Application

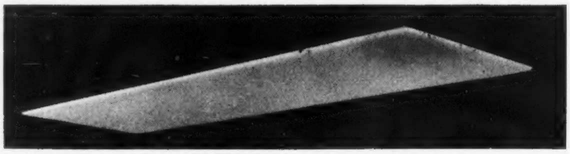
The 400-watt MA/V lamp used horizontally (since in that position it can be optically controlled with the maximum efficiency) is used extensively in floodlights. This lamp should have magnetic arc deflection, although this can be obviated by using the less efficient and somewhat more expensive MA/U lamp. When used, however, with arc deflection, the angular displacement of the lantern is limited to ± 10 deg., and while this is sufficient for normal operation, there would be an advantage if the lantern could be adjusted over wider angles. The new 1-kw. MA/H lamp has this advantage and, in a new lantern designed for use with this lamp, will give nearly three times as much controlled light from one lantern as from three 400-watt floodlights, and show a great saving in initial and running costs.

New Products

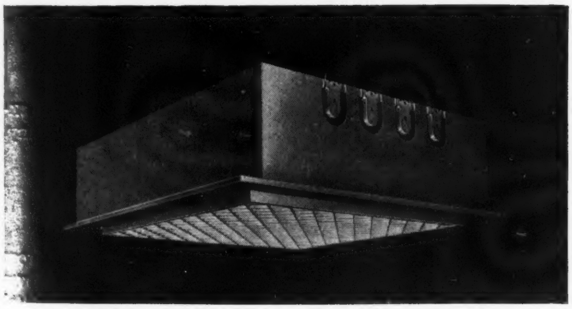
"Module" Fitting

The B.T.H. Co., Ltd., announce a new series of recessed lighting fittings known as "Module" fittings. In general with the modern movement for modular co-ordination, they are made to dimensions acceptable to the building industry, the aim being to eliminate the practice of cutting to waste where a building component, such as a ceiling panel, meets another, such as a lighting fitting.

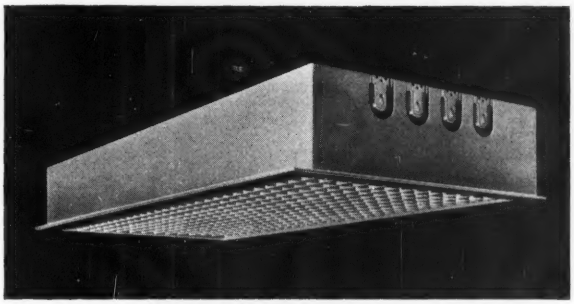
The "Module" fittings are made in 2 ft. x 2 ft., 2 ft. x 4 ft., and 2 ft. x 6 ft. sizes and are completely interchangeable with standard 2 ft. x 2 ft. or 2 ft. x 1 ft. ceiling panels, of which a wide selection of proprietary brands are used. "Module" fittings may be installed in a standard suspended ceiling in any desired arrangement and they may



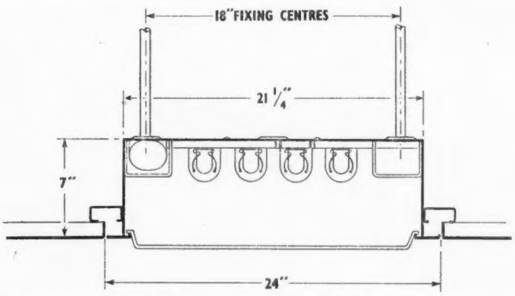
"Mazda" 6-ft. "Module" with moulded "Perspex" diffuser in a Frenger ceiling.



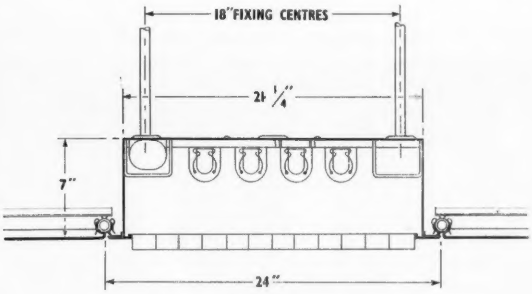
2-ft. "Module" for use in false ceiling; with diagonal polystyrene louvre.



4-ft. "Module" with metal "egg-crate" louvre.



Fitting of "Module" in Cullum Acousti-Celotex ceiling.



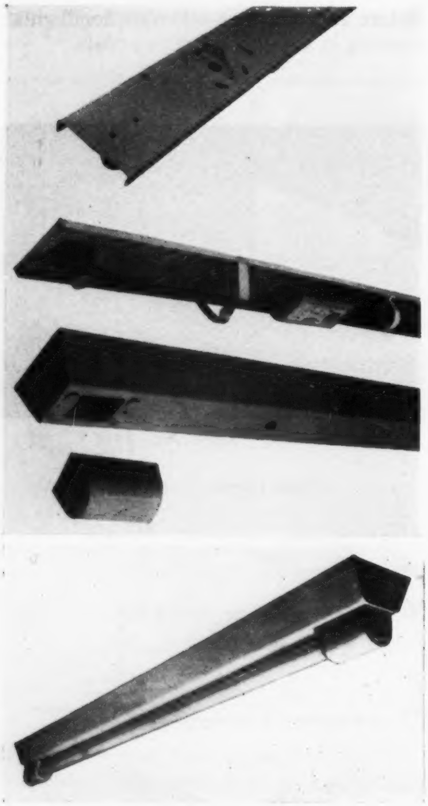
Fitting of "Module" in Frenger ceiling.

be rearranged at any time to suit new requirements without structural alterations.

The fittings may be mounted adjacent to each other without overlap because they are suspended independently of the false ceiling and completely integrated with the ceiling panels. They consist of a box constructed of sheet steel with a flange that sets into the ceiling. They are available housing two or four fluorescent lamps with control gear or tungsten filament lamps. A wide variety of diffusing panels may be used to obtain different lighting effects, including opal "Perspex" biscuits, diffusing glass and metal or plastic louvres.

Fluorescent Batten Fitting

Scemco, Ltd., announce a new "Triumph" 5-ft. 80-watt batten fitting. It incorporates a new type of hook for suspension purposes which folds flat into a recess in the backplate. The illustration shows the component parts of the fitting, including accessibility to concealed starter by removal



of end cap. The fitting may be mounted flush on the ceiling or by conduit or chain suspension. The fitting has a double coat enamel finish and the choke is fully bitumened for cool and silent working. Fittings are individually packed.

Frontispiece

The photograph on p. 188 shows the interior of the National City Bank of New York, King Charles II Street. The lighting fittings used were supplied by Courtney, Pope (Electrical), Ltd., and are a slightly modified version of one of their standard fittings. They measure approximately 21 in. by 42 in. and house two 150-watt tungsten lamps.

Situations Vacant

LIGHTING ENGINEER with good knowledge of modern lighting practice required by E.L.M.A. company for planning and estimating Commercial and Industrial lighting schemes. Willing to travel in United Kingdom and overseas. Write stating age and experience to Box 8592, c.o. Charles Barker and Sons Ltd., 31, Budge Row. London, E.C.4.

The British Thomson-Houston Co. Ltd. require a PHYSICIST or an ELECTRICAL ENGINEER in their research laboratory at Rugby for work connected with the development of new types of electric lamps. In addition to the determination of the physical design and measurement of electrical and optical characteristics, the work involves the development of the associated circuitry which is often of special nature. Applicants are invited to send particulars of their qualifications to the Director of Research, British Thomson-Houston Co. Ltd., Rugby, quoting reference BE.

British Railways have vacancies in Lighting Section in Chief Civil Engineer's Department for young DRAUGHTSMAN capable of preparing schemes for interior and exterior lighting. Salary rising to £620 per annum at 36 years of age. Residential travel and other travelling facilities available. Applications to Chief Civil Engineer, British Railways, L.M. Region, Euston Grove, London, N.W.1.

Philips Electrical Ltd. wish to appoint a TECHNICAL/COMMERCIAL ASSISTANT to the manager of the Tungsten Lamp Department. The work entails sales promotion development of new applications and customer liaison. Candidates should be between 28/32 years of age with H.N.C. (Electrical) and/or C. and G. Cert (Illuminating Engineering). A keen interest in or experience of sales administration would be a decided advantage and the post offers excellent opportunities for advancement. Applications giving details of age, qualifications and previous experience should be addressed to the Personnel Officer, Century House, Shaftesbury Avenue, London, W.C.2, quoting reference W.A.K.

SALES ENGINEER required for sale of "Thorlux" Lighting Equipment, Nottingham, Leicester, Derby area. Apply F. W. Thorpe Ltd., Welby Road, Hall Green, Birmingham 28.

A leading Industrial Electrical Company requires a competent STREET LIGHTING ENGINEER. His duties will include estimating for both home and overseas illuminations, scheme planning to the British Standards Code of Practice, and supervision of complete contracts. This position carries a good salary, is pensionable and will provide ever widening prospects for the right man. Reply in strict confidence to Box No. 891.

LIGHTING SALES ENGINEER required in Newcastle and Northern Counties. I.E.S. Registration an advantage. Write, giving particulars of sales and lighting experience and salary required.—Holophane Ltd., Elverton St., Westminster, London, S.W.1.

Situation Wanted

REGISTERED LIGHTING ENGINEER (32), wide experience, wishes to represent reputable lighting company, Midlands area.—Box No. 892.

Premises to Let

Work room and storage space at Dover. Available from 9d. per sq. ft. exclusive. On main road ½-mile from town centre. All services. Units of 3,000 sq. ft. upwards. Total space 42,000 sq. ft.—Write Box No. A.396, Willing's 362, Grays Inn Road, London, W.C.1.

I.E.S. Activities

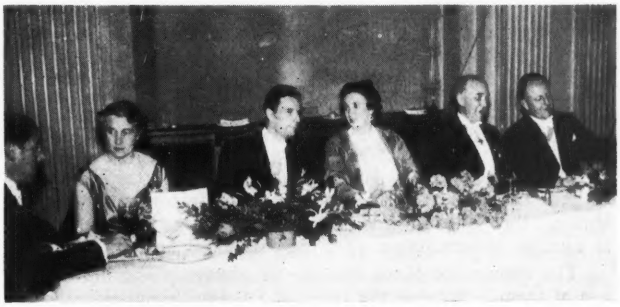
Society Annual Dinner

The annual dinner and dance of the I.E.S. took place on Wednesday, April 20, at the Café Royal, London. Some 260 members and guests were present, the principal guest being Mr. J. Eccles, president of the Institution of Electrical Engineers and deputy chairman of the Central Electricity Authority.

Mr. Eccles, in proposing the toast of "The Illuminating Engineering Society," said: The first creative fiat of recorded history was the simple injunction, "Let there be light." So it may be said with truth that your Society is following in a great tradition if on a somewhat smaller scale.

You are now in your forty-sixth year. During the period since your inception in 1909, you have grown in membership and influence in a quite remarkable way. Your development has not unnaturally coincided with the growth of the art and science of lighting, and, like the egg and the chicken, it is not yet certain which is cause and which is effect.

What a world it must have been when artificial illumination was confined to the farthing rushlight, and, later, to the open wick paraffin lamp. These aids were just enough to make darkness visible, and, when one remembers, too, that spectacles were either not available or not adapted to the changing needs of age, the opportunities for cultural refreshment through literature must have been very limited between dusk and dawn. There was plenty of time for reflection, which may account for the steady stream of

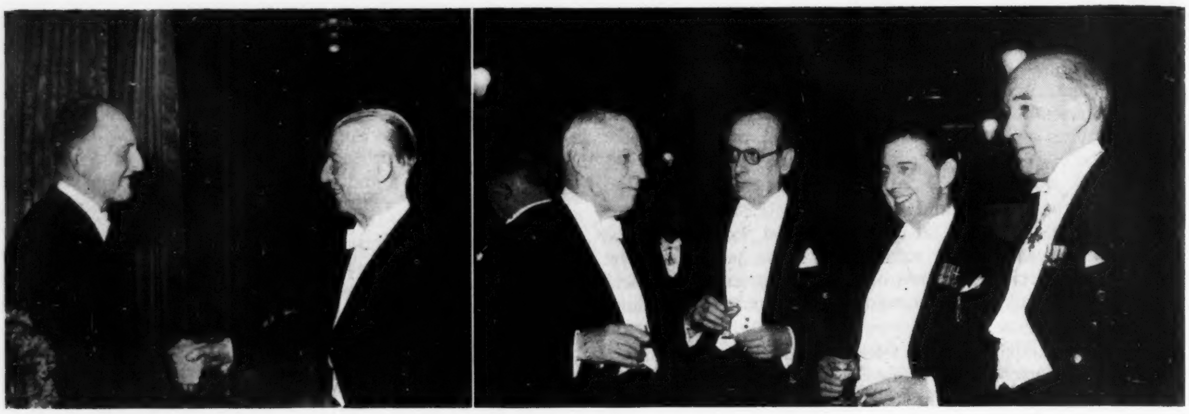


Above: *The President and Mrs. Lennox.*

Right:
Top:- *Mr. H. G. Campbell, Mrs. Harper, Mr. V. C. H. Creer, Mrs. Lennox, Mr. J. Eccles, The President.*

Centre:- *Mr. L. C. Penwill, Mr. A. F. Plummer (President E.C.A), Mrs. Plummer, Mrs. Harper, Mrs. Cole, Dr. W. E. Harper, Mrs. Penwill.*

Bottom:- *Mr. A. G. Higgins, Mrs. Tate, Mrs. Higgins, Mr. W. K. Tate (President Inst. Gas Engs.), Mrs. Mathews, Mr. E. D. J. Mathews, (Vice-President R.I.B.A.)*



Left: The President greeting Mr. Ayres, Chairman of the N.E. Electricity Board. Right: Mr. V. Dale, Mr. H. Pocock, Mr. Guy Campbell and Mr. Eccles.

philosophic writings and utterances that characterised the pre-industrial age. Would Homer, Socrates, Bacon or Browning have reached the heights if the cinema, television and the fluorescent lamp and animated advertisements had been their nightly lure? It is something we shall never know.

To-night, thanks to your efforts, the scene is changed. Outside the advertising signs cry their wares in dumb animation, good street lighting has increased the chances of pedestrian survival, and, in home and factory, shop and shrine, the quality and quantity of artificial lighting is capable of reaching a very high standard indeed.

The means are there, but do we always make the best use of them? What is the value of intense illumination if it only produces glare? What is the value of colour matching if we mutilate the spectrum and the home? And oh the murder of the lovely lipstick by your sodium monochrome. These are matters to which, no doubt, your Society is giving constant and urgent attention, and I wish you every success in your great work.

I congratulate you on having achieved your forty-fifth birthday, on the work you have done so far and on the spread of your wholly beneficial influence. In the future we shall require more well-trained illuminating engineers. I think it is right to stress the fact that such engineers should receive a broad basic training before specialising in this work, but of the need for specialists there can be no doubt, and electricity boards owe it to the public, whom they serve, to provide a staff with an expert knowledge in this important sphere.

Mr. Lennox, after expressing the appreciation of the society that the toast of the I.E.S. should have been proposed by the president of the Institution of Electrical Engineers and after thanking Mr. Eccles for his kind remarks, said:

On reflection, the president of the I.E.E. is a very appropriate person to propose the health of the I.E.S., as have not certain members of the Institution developed the electric lamp from the days of Swan to the wonderfully efficient lamps of to-day; and secondly was not the electricity supply industry started 73 years ago for the main object of supplying electricity for lighting purposes? To-day, we who are in that industry, are proud that an engineer of such considerable experience and ability as Mr. Eccles should be the deputy chairman of the Central Electricity Authority. The development in the use of electrical energy is of course enormous and its uses have extended well beyond the lighting field—but lighting is still "big business"; some 22 per cent. of the units used nationally are for lighting purposes and this consumption produces some 36 per cent. of the total revenue. Notwithstanding this enormous development there is still much work to be done in the improvement of lighting.

I see from the menu card that the Honorary Secretary has attached quotations to the names of the speakers. In my case from Goethe—"I can promise to be upright, but not to be without bias." This may, of course, have reference to my position in the lighting world as a competitor to my friends in the gas industry where undoubtedly I confess to not having been without bias on certain occasions—but in the I.E.S. we have no such bias. We have together an ideal of bringing a realisation of better lighting values to all concerned. There is one matter which these two great industries—gas and electricity—have in common. Lighting was the first love of both and they were formed for the purpose of providing artificial lighting. It is said:—"Love starts when she sinks in your arms and ends when she has your arms in her sink." Is it not so then with the first love of these industries? Lighting, first acclaimed as wonderful, is now accepted all too often as the drudge or Cinderella without thought of its wonderful possibilities. We all here know of cases of poor lighting in factories, shops, streets and houses. It is the aim of this Society that better lighting be developed in all these places for the improvement of output in factories, improvement of safety in factories, improvement of safety in the streets and of health and happiness in the home.

Although this Society was founded some 46 years ago, this is the 25th anniversary of the year of its Incorporation and so we are able this year to celebrate what might be called the Silver Jubilee of Incorporation. It would be a Jubilee present of some significance if this year H.M. Government were to recognise the value of lighting in several spheres. In the office, drawing office and so on, a minimum value of lighting has been determined in a private Bill which was recently before Parliament, but I would like H.M. Government to recognise the value of adequate street lighting as a contribution towards the reduction of accident rates at night. It has been well established that it is five times as dangerous to make use of the highway at night than by day. It has been shown that in one year the increase of accidents to pedestrians was 3 per cent. by day with an 18 per cent. increase at night. Surely we long ago reached the conclusion that additional street lamps can do no harm. Yet at the present time the Road Traffic Bill, which has as its object the improvement of highways and traffic routes so that they may be used with greater safety, which provides additional grants for the capital contribution of the works involved and for the maintenance of the roadways—a Bill which must

have emphasis on safety—makes no provision for grants for lighting purposes. The reason no doubt lies in the fact that lighting of traffic routes is not under the same administration as the provision and maintenance of the highways themselves—but this is surely a matter for correction by H.M. Government. We do not ask for a lot of money for the purpose of traffic route lighting, where considered necessary. We are well aware of the present costs of administering to the general public needs. Indeed, we know that " no person who has to ask the price of a mink coat should ever think of buying one." We do not want " mink coat " class of street lighting. We do not want high-class street lighting for these roadways, but we do believe that the cost involved in providing adequate lighting on these traffic routes, where required, is already being paid several times over in the cost of the accidents which could be avoided with better lighting.

To achieve these aims we need the help of all our friends —engineers, architects, contractors and manufacturers. We need the active co-operation of senior members of these bodies, not only as members of the Society but to present papers and to take part in discussions, so that the work of the Society can go forward and that the great benefits which can come to you by better lighting be appreciated and obtained by all concerned.

The toast of " The Guests " was very ably and humorously proposed by Dr. W. E. Harper, vice-president. He referred to the various industries and professions with whom the lighting engineer has to co-operate, and said that the Society was very happy to welcome representatives of a number of kindred bodies, including a vice-president of the R.I.B.A., the chairman of E.L.M.A., the presidents of the A.P.L.E., E.C.A., E.L.F.A., and of the Institution of Gas Engineers and the Director of E.D.A.

The reply on behalf of the guests was made by Mr. V. C. H. Creer, chairman of E.L.M.A., in a brief and witty speech, in which he thanked the Society for the high standard of their hospitality.

Nottingham Centre

A sessional meeting was held on March 3, when Professor W. D. Wright, Professor of Technical Optics at the Imperial College, London, presented his paper " Colour and Colour Vision."

A large gathering of some 54 members and friends attended. Art students from the Nottingham University and College of Arts were present and took part in a lively discussion which followed.

The annual " Ladies' Evening " of the Centre took place at the Victoria Station Hotel on March 11, when the guests included the Sheriff of Nottingham, Councillor J. Mitson, Mr. R. Ringham, chairman of the East Midlands Division National Coal Board, and the president of the Society, Mr. E. C. Lennox.

The toast of the City of Nottingham was proposed by the chairman. Dr. A. Roberts, who referred to the City in glowing terms, and particularly to its educational facilities. The Sheriff, in his reply, congratulated the Society on its work, and made reference to the excellent lighting in the city.

Mr. W. H. Dodgson proposed the toast to the Ladies in an extremely witty manner; Mrs. Roberts made an excellent response.

Mr. R. Ringham, when proposing the toast of the Society referred to the great part played by the work of members of the Society in coal mining, and said that improved lighting in mines would greatly enhance the prospects of improved recruitment in the industry. The president, Mr. E. C. Lennox, responded to this toast in an extremely witty manner, which was received with acclamation.

The tables during the evening were illuminated with miners' lamps as a tribute to the work done in this field by the chairman.

At the meeting held on April 7, Mr. J. Studholme presented a paper on " Compromise in Lighting Fittings Design." Mr. Studholme laid stress on the compromise necessary to balance accurate fitting design against the difficulties presented by the use of general lighting service lamps. This led to good discussion which was opened by Mr. P. Moore. A vote of thanks to Mr. Studholme was proposed by Mr. D. R. M. Hornsey.

Birmingham Centre

The Centre brought to a conclusion its 1955 sessional meetings, on April 22, when Mr. D. A. Strachan presented a paper entitled " The Design and Application of Flameproof Lighting Equipment." Mr. Strachan illustrated with extremely accurate slides the many and varied applications of this type of equipment, and dealt particularly with the reasons for specific designs. He first of all touched upon the many kinds of conditions which might cause an explosion, such as hot wires, bare wires, naked flames, friction, hot surfaces, etc. He then illustrated with tables the different gases and dusts likely to be involved in an explosion, and stressed the fact that experience had shown that flanges of metal to metal were far superior to types involving rubber packing rings.

Mr. Strachan emphasised that flameproof equipment had to be used as a last resort, if it was not possible to get rid of the cause of the danger by other methods. He dwelt on the importance of the correct classification of hazards so that the right kind of fitting could be used. He stated that the Buxton " F.L.P." Certificate was most stringent and was not granted lightly or without careful testing of apparatus. An interesting film was shown, which clearly demonstrated how this testing was carried out.

Mr. Hartill opened the discussion following the paper, dwelling on gas temperature and industrial dust, which did not appear to be classified as yet.

Mr. Strachan was warmly thanked by the members for a most instructive and entertaining evening.

Guests at the Nottingham Centre "Ladies Night" with the chairman, Dr. A. Roberts, and the President, Mr. E. C. Lennox.

Lighting Abstracts

OPTICS AND PHOTOMETRY

535.24

158. A lumen integrator for semi-automatic distribution photometers.

W. G. PRACEJUS AND G. H. ZAAR, *Illum. Engng.*, **49,** 589-590 (*Dec.*, 1954).

Describes a further step towards the ultimate achievement of a completely automatic photometric laboratory. The integrator works in conjunction with a semi-automatic distribution photometer. A signal proportional to the instantaneous candlepower recorded by the photometer is fed into the integrator. Here it is combined with the appropriate sine function and continuously integrated over zones of half-, one- or five-degree extent. The resultant integration is fed into a decimal printer from which a simple addition will produce the total lumens. P. P.

612.843.36

159. Effect of a peripheral glare source upon the apparent brightness of an object.

G. A. FRY AND M. ALPERN, *Illum. Engng.*, **50,** 31-38 (*Jan.*, 1955)

Describes a new study in which the reduction in apparent brightness of an object viewed near a disabling glare source is related to the same reduction produced by a veiling brightness superimposed on the visual field. Experimental details and some results are given. A relationship has been derived between the physical variables similar to others previously obtained by Holladay, Stiles and Dunbar. Potential applications of the data to illuminating engineering problems are briefly referred to. P. P.

LAMPS AND FITTINGS

160. Lamps and their uses. 621.32

J. N. ALDINGTON, *Trans. Illum. Eng. Soc.* (*London*), **19,** 319-335, (*No.* 10, 1954).

Describes the fundamental methods of producing light, discusses the evolution of modern light sources and considers some basic principles underlying lamp design in relation to user requirements. Mention is made of the problem of determining the optimum colour for fluorescent lamps for different uses. The view is expressed that the active phase of lamp invention and discovery is now merging into a period of consolidation; that developments in light sources have outstripped developments in application; and that there is a wide gap to be closed between the best lighting and the standards tolerated in most lighting applications. W. R.

161. Design of high-output fluorescent lamps. 621.327.43

A. C. BARR AND W. J. KARASH, *Illum. Engng.*, **50,** 5-13 (*Jan.*, 1955).

Details are given of such design factors as lamp length, tube diameter, lamp operating current, filling gas and control gear which have had to be studied in the development of a fluorescent lamp having a high lumen output. The result has been an 8-ft., 1½-in. diameter, argon-filled lamp operating at 0.8 amperes. Lumen data of this and other similar lamps are given, but mainly as relative, rather than absolute, values. P. P.

LIGHTING

628.972

162. The decorative approach to commercial lighting.

ANDRE CLAUDE, *Trans. Illum. Eng. Soc.* (*London*), **19,** 341-349 (*No.* 10, 1954).

Discusses the problems raised by fluorescent lamps in decorative lighting and stresses the need for the combination of artistic conception with sound lighting engineering. Reference is made to the multiplicity of white lamps and the view is expressed that, for artistic purposes, lamps with a predominantly red emission and with the spectrum carefully graded to avoid a purple effect are best. The French D.M.S. system, employing krypton-filled tungsten ballast lamps, is described and discussed in relation to decorative lighting requirements. The aesthetics of the use of colour both in interiors and for luminous signs are discussed. W. R.

163. Home lighting. 628.972

A. H. YOUNG AND C. J. MISSELBROOK, *Trans. Illum. Eng. Soc.* (*London*), **20,** 37-49, (*No.* 1, 1955).

Reviews developments in domestic lighting from 1928 to the present and endeavours to show some possible lines of future progress. The large range of materials used in the manufacture of lighting fittings designed for the domestic market is discussed. The problems of lighting various rooms in the home are considered and the possible reasons for the lack of interest in fluorescent lighting are analysed. Suggestions for the developments necessary before fluorescent lighting can be introduced successfully into the domestic lighting field are made. A plea is made for an approvals system to be applied to lighting fittings designed and sold for domestic use to ensure adequate safety. British, Continental and American practice is compared. W. R.

164. Lighting and electricity supply. 628.9

E. C. LENNOX, *Trans. Illum. Eng. Soc.* (*London*), **20,** 1-13, (*No.* 1, 1955).

Traces the historical development of electricity supply with special reference to lighting, and discusses the contribution of lighting to present day living. The view is expressed that improved light sources, by extending the scope of lighting improvement in every sphere, have given a new impetus to development by the supply industry as well as by the lighting industry at large. An appeal is made for a greater measure of co-operation between all agencies concerned. W. R.

165. Lighting and visibility in mines. 612.84:628.97

A. ROBERTS, *Trans. Illum. Eng. Soc.* (*London*), **20,** 15-36, (*No.* 1, 1955).

Discusses the effect of lighting on productivity and safety in mines and the basic requirements. The visual conditions at the coal face are studied by means of perspectives in the case of general lighting and lighting by cap lamps. Typical illumination levels and luminance ranges are shown by means of photographs and the various visual tasks are analysed. It is shown that cap lamps alone are insufficient but that they can serve a useful purpose in supplementing general lighting. W. R.

166. Graphical representation of utilisation data. 628.93

R. D. BURNHAM, *Illum. Engng.*, **50,** 43-45 (*Jan.*, 1955).

The component parts of the Harrison-Anderson lumen method equation are grouped together so that the average room illumination can be predicted from the products of the number of luminaires, the luminaire constant and the room coefficient (utilisation factor divided by room area). The luminaire constant is a function of the design of each individual luminaire. The room co-efficient is dependent on the room configuration, luminaire distribution and reflection factors of the principal surfaces. A quadrulux diagram (i.e. four juxtaposed and inter-related graphs) is offered whereby the room coefficient can be simply calculated by a graphical technique, so obviating the need for a number of coefficient of utilisation tables. P. P.

Revision of the C.I.E. Colorimetric System

It is well known that for some time past there has been, especially in the U.S.A., dissatisfaction with some of the data defining the "standard observer" in the C.I.E. system of colorimetry. In particular it is thought that the values of the relative luminous efficiency factor Vλ (formerly the visibility, or luminosity factor) are too low at the blue end of the spectrum. The values of this factor were adopted (be it noted "provisionally") in 1924 and the other colorimetric data in 1931 so it would not be surprising if small imperfections were to be found. The only question to be decided is whether, in view of the considerable differences between individuals and the changes that can be brought about by altering the conditions of observation, any modification of the data which have been so widely used for the past two decades is justified.

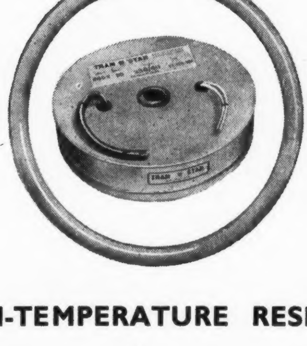
The C.I.E. decided in 1951 to ask the National Physical Laboratory in this country to carry out an extensive programme of work on a large number of observers to redetermine the colorimetric data and at the meeting of the Colour Group on the 27th of April Dr. W. S. Stiles gave an account of the progress made so far. He mentioned that Ishak and Teele in America had redetermined the Vλ curve at the blue end of the spectrum, using over 100 observers. At the N.P.L. they had so far made complete sets of observations on 30 observers, using two sizes of visual field, viz., 2 deg. and 10 deg. They had found that the values obtained, especially those for the smaller field, indicated noticeable departures from the additivity law. He hoped that at Zurich a decision would be reached as to which field size was to be used in the main investigation on a large number of observers.

Dr. Stiles was followed by Dr. R. W. G. Hunt who said that if changes were to be made in the standard observer data on which the C.I.E. system was based, the chromaticity diagram now in common use would become obsolete. In this event, he said, the opportunity might well be taken to standardise a chromaticity diagram, based on the new observer data, which was more nearly uniform in chromaticity, i.e., such that equal differences of colour were represented by more or less equal distances on the diagram. He described in particular the relative advantages and disadvantages of the present C.I.E. diagram, a form of diagram proposed by the American Committee on Colorimetry and a diagram suggested by MacAdam.

Mr. R. G. Horner then followed with a diatribe against chromaticity diagrams designed by mathematicians to facilitate colour computations. He said that the purpose of the diagram was to display information and it should be designed to be of use to those who were concerned with the practical uses of colour. Ease of interpretation should be the paramount consideration; points representing different colours should be distributed so as to indicate hue and in this respect the C.I.E. diagram could be most misleading. He said that there was no reason why a new standard method of plotting should not be made to exhibit features which correlated reasonably well with the properties of the colour solid of surface colours; it was surface colours which were of the greatest interest to the majority of users.

TRAN ✱ STAR
REGD. TRADE MARK
CONTROL UNITS

DISC UNITS
FOR THE NEW
CIRCULAR
LAMPS



WITH $\frac{3}{4}''$
MOUNTING
FOR CENTRAL
FIXING

FITTED WITH HIGH-TEMPERATURE RESISTING CAPACITORS
and
GUARANTEED FOR 3 YEARS

Sole Manufacturers:
INDUCTIVE APPLIANCES LTD. 18, DEAN STREET, NEWCASTLE UPON TYNE 1
Tel. Newcastle 27069
Works Tel. Hebburn 32221

POSTSCRIPT By "Lumeritas"

The new I.E.S. Code for Lighting in Buildings, which I mentioned last month, has now made its appearance. It will be reviewed in detail in the next issue of *Light and Lighting*, so I shall confine my comments to two interesting terms which—although not new—appear for the first time in the British Code. The first of these is "luminance" and, for the benefit of readers who are not yet clear about its meaning (if there are any such), this is the word recommended by the International Illumination Commission in 1951 for denoting photometric brightness. The latter, of course, is not the same "thing" as apparent or subjective brightness for which the term "luminosity" is now used. The use of the word "luminance" whenever reference is intended to "brightness" which is objective, measurable and independent of the state of adaptation of the eye which affects our unmeasurable sensations of "brightness," is surely preferable to using the word "brightness" ambiguously or to using the two words "photometric brightness" to avoid ambiguity. The second term I am glad to see in the new Code is "luminaire." In the previous Code luminaires were referred to as "lighting units"—not a happy terminological choice since, out of context, it could be thought to be synonymous with "photometric units." A footnote in the 1949 Code explained that "A lighting unit usually comprises a source of light together with equipment designed to control the distribution of light, to limit the brightness within a suitable angle of view and sometimes to be decorative." This is precisely what the word "luminaire" was intended to mean when it was proposed to the International Illumination Commission in 1924 at Geneva. As far as I know no one has since proposed a more suitable word and, although it has not been "officially" recommended, it is widely used. It was originally suggested by the United States, but I notice that as early as 1926 it was used by Lythgoe in one of the Reports (Med. Res. Coun. Spec. Series Reports, No. 104, Illumination and Visual Capacities) listed in the Documentation Appendix to the new I.E.S. Code. It is sometimes contended that "lighting fitting" has the same meaning as "luminaire" but surely this is not so and, anyway, why use two words when one will serve so well?

While on the subject of terminology, one of my acquaintances (sometimes dubbed a "purist"—which seems to mean a fellow who hankers after greater verbal propriety than other fellows bother about) recently raised with me the vexed (or should I say the neglected?) question of a short word meaning "lumens per square foot." The following dialogue ensued :—

He : I prefer "lumens per square foot" to "foot-candles," though it is unfortunately long in the saying. Why not coin a suitable word, say, "lupa"?

Me (in the manner of the immortal English lexicographer): Sir, of the making of new words there is no end and pray, Sir, what is suitable in that you propose?

He: Has it not brevity? Is it not distinctive whether written or spoken? Is it not shorter even to write than the abbreviation "lm/ft^2," and much shorter than "foot-candle"? Is it not a rational invention and easy of assimilation?

Me: Sir, I do not deny it the merits which commend it to you and, indeed, to me: though to be sure it is not descriptive and there be those who will quiz you why you call it rational.

He: Is "foot-candle" intrinsically descriptive, or "lux"? As for my word, is it not reasonably constructed from the common root "lu" of various lighting terms and the initial letters of the other words, only excepting that of "unit"?

Me: Sir, these are cogent points. Indeed, we live in an age of words built from others by their first letters, and not all of them are abhorrent. Yet "rational construction" will avail you little, men being irrational as to what they like and dislike.

He: You are a cynic; but I am content to advance my proposal on its other merits.

Me: Sir, I would remind you others have done as much. Yet their proposals have wanted ophelimity, or there have been few to share their love of brevity, or over many innured to the *mésalliance* of the foot and the candle. Sir, I beg you abandon your proposal. It has my approbation; be content with this for it will get no other. Sir, I'll wager you a luminaire to a nit your proposal will come to naught. If it should not be so, I make no doubt you will have no claim to my forfeit till you and I are dust.

Perhaps it is hardly worth changing the subject now that so little space remains to me, so I shall add another comment upon lighting terminology. What is the meaning of "glare"? As one answer, I will quote the Editor of the Journal of the Optical Society of America, as follows: "Glare is a term which is much abused and should not be used unless accurately defined. To some, on an ice surface or snow bank, glare implies reflected rather than direct light. Whereas, with an oncoming light of considerable brightness, glare is used to apply to the direct rather than the reflected radiation. In either case glare is unwanted light as compared with wanted light, both with respect to intensity and source." In this, it is perfectly plain that "glare" is referred to the light —it is a name applied to the visual stimulus when it is excessive or "unwanted," and this, indeed, is its use in common parlance. It is used in this sense in the second of Lythgoe's Reports cited in the new I.E.S. Code, where he writes of "glare shining into the eye." Others, however, apply the term "glare" to a condition of vision and in the International Lighting Vocabulary (1938) "glare" is defined as "the disturbance of the sensitivity of the eye experienced when portions of the field of view have a brightness or intensity greatly in excess of that of the average for the field of view." Now, we should not have it both ways and, in my way of thinking, "glare" means the disturbing light and not the resulting disturbed condition of sight.